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IDAHO CHEMICAL PROCESSING PLANT

SAFETY DOCUMENT

Section 8.6

MANAGEMENT OF RADIOACTIVE AIRBORNE EFFLUENT

November 2000

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DOES NOT CONTAIN UNCLASSIFIED CONTROLLED NUCLEAR INFORMATION

REVISION LOG

Rev.	Date	Affected Pages	Revision Description
0a	11/00	92, 93, 105, 111, 153, 154, 155, 156, 157, 176, 178, 179, 180	See DAR 98-06-21.
0	2/96	All	R. M. Stallman, Letter to R. N. Gurley, "DOE Approval of Radioactive Airborne Effluent Safety Document Revisions (OPE-CPP-96-010)," dated February 5, 1996.

NOTES

Throughout the text of this Idaho Chemical Processing Plant Safety Document section are many items that are highlighted in bold italicized text. These highlighted statements contain safety analysis assumptions that are the foundation for the safety envelope. Additional material that is contained in tables, etc., may not be highlighted. However, where equipment operability requirements and other such data are included in the tables, these items are also part of the foundation for the safety envelope. Any design modifications or procedural changes that would alter these highlighted statements and lists in tables must be evaluated per Idaho Chemical Processing Plant procedure WS-400 to determine the unreviewed safety question (USQ) status of the proposal.

Safety analysis report assumptions include 1) process design or operating parameters affected by either upstream or downstream processes, 2) safety analysis report assumptions referenced in the accidents or postulated abnormal occurrence (PAO) discussions, and 3) Department of Energy (DOE) or national code requirements that affect continued operation of the facility as prescribed by the safety envelope. These assumptions are highlighted in bold italicized text.

Changes affecting controls cited in the accident or PAO discussions must be reviewed relative to the safety analysis before changes can be implemented. Changes to DOE or national code requirements must also be reviewed relative to the potential changes in the interpretation of the safety envelope.

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Figures

Tables

ACRONYMS

AEDL	Applied Engineering and Development Laboratory
ALARA	as low as reasonably achievable
AMAD	average median aerodynamic diameter
AMD	aerodynamic mean diameter
ANS	American Nuclear Society
ANSI	American National Standards Institute
APS	atmospheric protection system
ARP	atmospheric release point (point of release from a stack or vent)
ASME	American Society of Mechanical Engineers
BIO	basis for interim operation
CAM	constant air monitor
CAS	criticality alarm system
CEDE	committed effective dose equivalent
CFA	Central Facilities Area
CFR	Code of Federal Regulations
CPM	continuous process modification (a fuel dissolution process)
D&D	decontamination and decommissioning
DAC	derived air concentration
DBA	design basis accident
DBE	design basis earthquake
DBF	design basis fire
DBT	design basis tornado
DBW	design basis wind
DCS	distributed control system (a process control and notification computer system)
DOE	Department of Energy
DOE-ID	Department of Energy, Idaho Operations Office
DOG	dissolver off-gas (E-DOG, CPM-DOG, etc., depending on process)
DOP	dioctyl phthalate (used for in-place testing of HEPA filters)
EBR-I	Experimental Breeder Reactor I
ECC	Emergency Control Center
E-DOG	E-cell dissolver off-gas
EPA	Environmental Protection Agency
ERDA	Energy Research and Development Administration

ESF	engineered safety feature
EVA	extreme value analysis
FAST	Fluorinel Dissolution Process and Fuel Storage Facility
FDP	fluorinel dissolution process
FSA	Fuel Storage Area
FSAR	final safety analysis report
H&V	heating and ventilating
HEPA	high-efficiency particulate air
HEU	highly enriched uranium
HPP	Headend Processing Plant
HVAC	heating, ventilating, and air conditioning
ICPP	Idaho Chemical Processing Plant
ICPP SAR	Idaho Chemical Processing Plant Safety Analysis Report
IDLH	immediately dangerous to life or health
INEL	Idaho National Engineering Laboratory
LC	Designator for 602 Laboratory Building, Lower Level (Laboratory C)
LCO	limiting condition for operation
LCS	limiting control setting
LET&D	liquid effluent treatment and disposal
LMITCO	Lockheed Martin Idaho Technologies Company
MFP	mixed fission product
MIR	maximum individual risk
NOAA	National Oceanic and Atmospheric Administration
NPH	natural phenomena hazard
NRC	Nuclear Regulatory Commission
NRTS	National Reactor Testing Station
NWCF	New Waste Calcining Facility
OBE	operational basis earthquake
OSR	operational safety requirement
PA	public address
PAO	postulated abnormal occurrence
PCWS	process control and warning system
PDI	pressure differential indicator
PEW	process equipment waste (also used to designate the process used to treat low-level liquid waste)
PM	preventive maintenance

POG	process off-gas
PSD	Idaho Chemical Processing Plant Safety Document
QA	quality assurance
R&ES	radiations and environmental safety
RAF	Remote Analytical Facility
RAL	Remote Analytical Laboratory
RAM	radiation area monitor
RCM	DOE Radiological Control Manual
RCT	radiological control technician
RG	regulatory guide
RGP	Rare Gas Plant
RMHF	Radioactive Materials Handling Facility
RWMC	Radioactive Waste Management Complex
SAR	safety analysis report
SL	safety limit (defines limit in support of safety envelope for operations)
SOG	sample off-gas
SOP	standard operating procedure
SR	surveillance requirements
SS	safety significant
SSC	structures, systems, and components
TEDE	total effective dose equivalent
TSR	technical safety requirement
TRA	Test Reactor Area
TRQ	technical safety requirement
TS/S	technical specification/standard
UBC	Uniform Building Code
UPS	uninterruptible power supply
USQ	unreviewed safety question
VOG	vessel off-gas
WCC	Warning Communications Center
WCF	Waste Calcining Facility

1. INTRODUCTION

The Idaho National Engineering Laboratory (INEL) is the site of the Idaho Chemical Processing Plant (ICPP). In 1949, the U.S. Atomic Energy Commission established the site as the National Reactor Testing Station (NRTS) for testing various types of nuclear reactors and associated equipment. The INEL is near the western edge of the Upper Snake River Plain in southeastern Idaho. It contains 2300 km^2 (890 mi^2 or 570,000 acres) with an average elevation of 1480 m (4850 ft) above sea level.

The ICPP receives, stores, and prepares many types of spent nuclear fuels for disposal, as assigned by the U.S. Department of Energy (DOE). The ICPP was originally designed as a fuel reprocessing plant to reclaim residual uranium from spent, highly enriched nuclear fuels. Fuel processing was discontinued, and the ICPP mission has changed. Waste, left as a liquid from fuel processing and decontamination activities, is calcined into solid granules for interim storage in high integrity solid storage bins and vaults. Liquid and gaseous waste streams from these processes are treated to comply with DOE and environmental standards.

The ICPP is in the south-central portion of the INEL in Butte County, about 67 km (42 mi) west of Idaho Falls. Figure 1 shows the relative location of the ICPP and the INEL boundary. The restricted area of the ICPP encloses 0.49 km^2 (0.19 mi^2 or 120 acres) of the total ICPP area which is 0.59 km^2 (0.23 mi^2 or 147 acres). The elevation of the ICPP is 1498.6 m (4916.6 ft) above sea level.

1.1 FACILITY DESCRIPTION

The ICPP is owned and administered by the DOE to receive, store, and prepare many types of spent nuclear fuels for permanent off-site disposition and to achieve waste minimization. The overall ICPP mission is to cost-effectively manage all activities in a manner that protects the safety of INEL employees, the public, and the environment. Part of

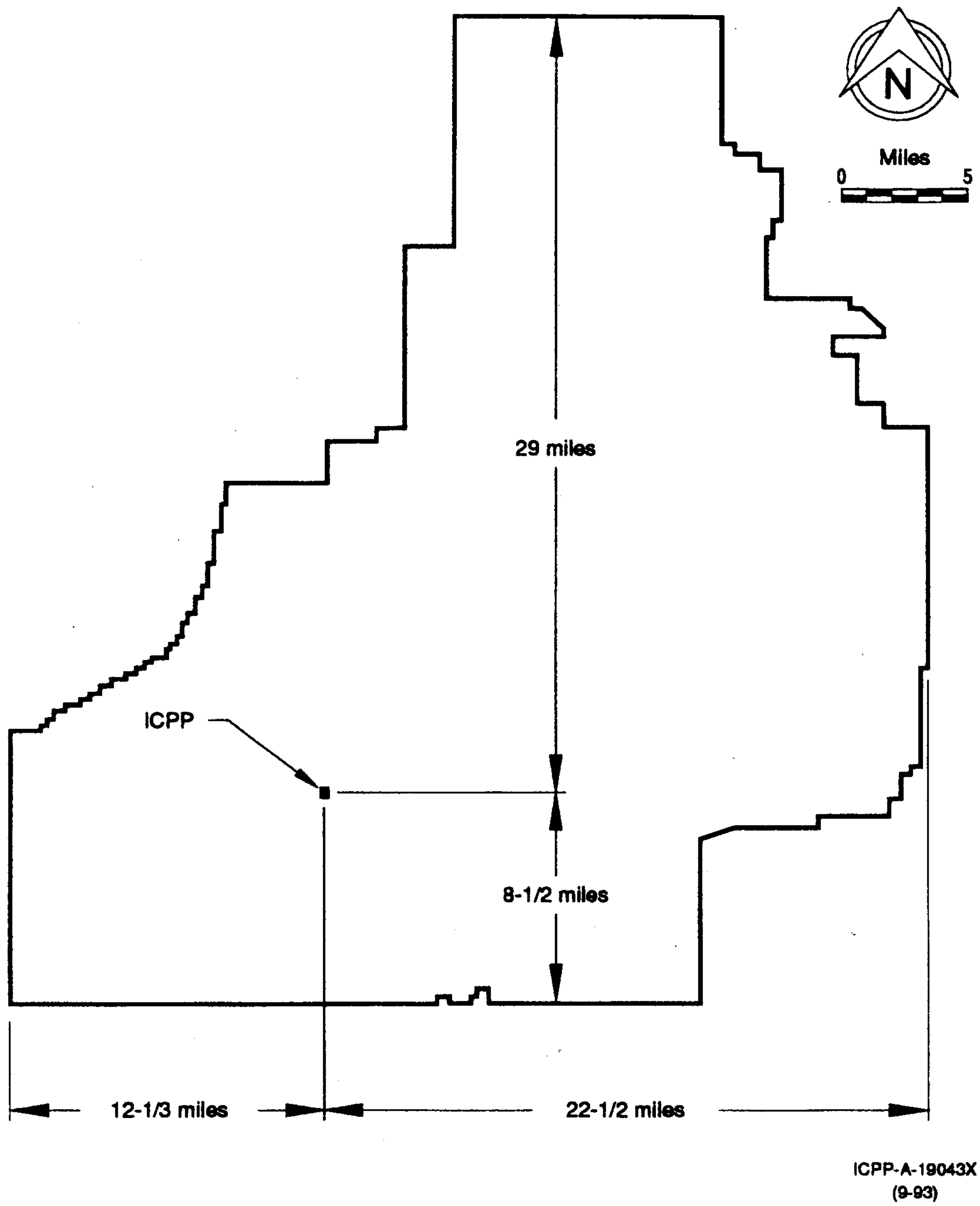


Figure 1. Location of the ICPP

the ICPP mission, as it relates to management of radioactive airborne effluent, is to manage all waste in compliance with applicable laws and regulations.

Historically, the ICPP was used primarily for safely disposing of spent reactor fuel by processing and recovering the uranium. The current mission of the ICPP is to handle and provide interim storage for spent fuels, calcination and immobilization of liquid waste currently in interim storage, decommissioning of terminated processes or facilities, and developing improved methods for the storage and disposition of nuclear waste. Each safety significant modification or addition to the plant requires a modification to the Idaho Chemical Processing Plant Safety Document (PSD).[1] The PSD revision requires DOE approval before operation of the new or modified system. The PSD describes the principal facilities at the ICPP. This description includes processing, laboratory, fuel handling and storage, waste treatment, etc. The major structures and general layout of the ICPP are presented in figure 2.

As a result of significant mission changes at the ICPP, several processes have been discontinued or placed in a safe shutdown configuration. Descriptions and controls written into the PSD may, in some instances, reflect a safety envelope required for operating functioning processes. These PSD sections often include provisions for decontamination.

Many of these processes and facilities will ultimately be decontaminated and decommissioned. As this occurs, the decontamination and decommissioning (D&D) processes will be evaluated against the approved PSD using the unreviewed safety question (USQ) process. The USQ evaluation may determine that the approved safety analysis report (SAR) is sufficient to maintain the safety envelope during D&D activities. It may also require some changes to the approved SAR or, in extreme situations, a new SAR may be required to provide adequate assurance for the safety envelope. This is true of the ventilation and off-gas systems.

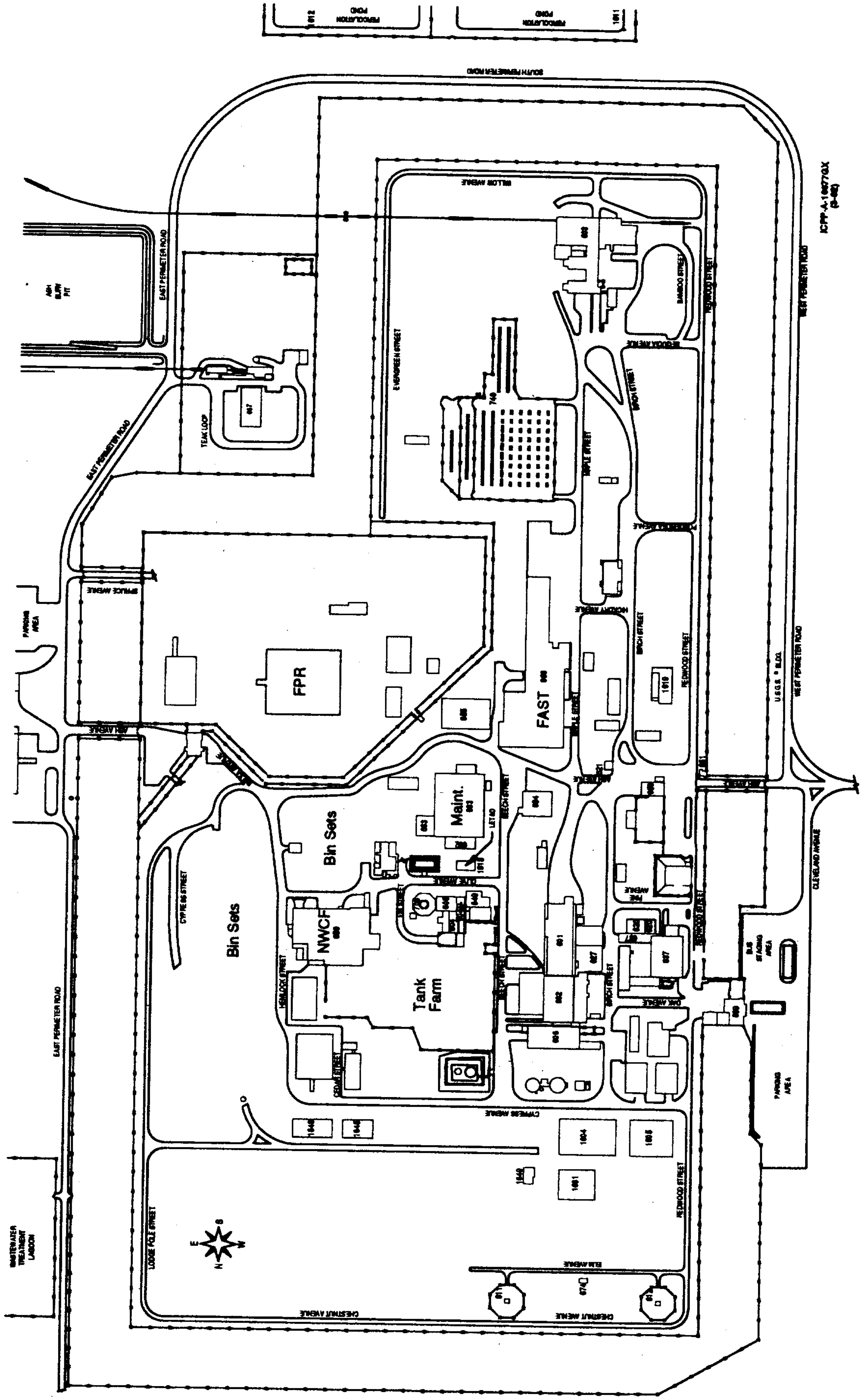


Figure 2. Major Structures and Layout of the ICPP

1.2 SCOPE OF ANALYSIS

This section of the PSD describes the ICPP radioactive airborne waste management systems. Airborne effluent includes gases, suspended solid particles, and liquid aerosols. This section does not describe ventilation systems which exhaust from nonhazardous areas such as office buildings. Individual descriptions of these facilities are located in other documents. The section also does not provide an in-depth discussion of ventilation and process off-gas systems for facilities where the descriptions of these systems exist in other sections of the PSD. Facilities such as the Fluorinel Dissolution Process and Fuel Storage Facility (FAST), Remote Analytical Laboratory (RAL), New Waste Calcining Facility (NWCF), and others contain descriptions of ventilation and off-gas flows and treatments in their respective PSD sections. This section of the PSD describes in detail the final systems through which radioactive effluent passes just prior to its release from the ICPP Main Stack. These treatment systems are located in CPP-649, CPP-756, CPP-604, and CPP-605. The equipment in these facilities consists of prefilters, condensers, heaters, blowers, and final high-efficiency particulate air (HEPA) filters. HEPA filters provide the final barriers against inadvertent releases of radioactive particulate which could cause a safety concern.

Equipment required to provide barrier functions serves as safety equipment. Secondarily, this same equipment may be used to monitor, or control releases which are of environmental concern but are not releases which pose an immediate or imminent health or safety hazard to the public. The control of normal, operating releases is a separate concern not always related to more immediate safety hazards. Equipment installed to monitor and record normal releases to the environment may be in addition to equipment required for safety reasons. There is equipment which provides functions for both considerations, useful for both environmental and accidental requirements. Equipment used for multiple purposes must be required for safety purposes before credit is taken for that function and before the more stringent requirements of acquisition, maintenance, and operation are applied to that equipment. The greater the safety need, the more strict are the requirements for equipment installed and operated to satisfy these needs. Safety class structures, systems, and components (SSCs) and safety class systems, as defined in DOE Order 6430.1A[2] [refer to p. viii through ix, SSCs and safety significant (SS)], provide the highest level of sophistication and operation in this hierarchy. These items are installed, operated, and verified to mitigate or prevent only the most serious accidents. Further discussion of equipment classification is found in subsection 1.2.1 and section 11.

While there are many federal and state documents required for effluent monitoring, DOE orders are, for safety purposes, considered the higher order document. To be considered as equipment required for safety purposes, the definition in DOE Order 6430.1A, section 1300-1.4.2, is used as primary guidance. Other considerations may be satisfied by the installed equipment, provided that these considerations do not conflict with or compromise the functions provided for safety.

Some of the older equipment and instrumentation provided for safety purposes were installed using older criteria than are currently used. Equipment installed to provide compliance with older criteria has been compared to more recent criteria and technologies. Using revisions to the operation and maintenance of equipment or, through actual equipment upgrades, current acceptable safety requirements are provided with the continued operation of older equipment.

Safety envelope limits have also been subject to change based upon recently revised regulations and DOE Orders (DOE Order 5400.5[3] and DOE/EH-0256T).[4] These revisions serve as a bridge between regulations to ensure environmental quality and releases that are accidental and acute in nature. An accidental release may not exceed an annual environmental limit and, therefore, limits defining accidental releases are occasionally based upon release rates rather than a total release per se. Definitions of accidental releases, in this context, may be based upon considerations that assume that a release, if continuous, would exceed the limits established for chronic normal releases. In this context, an accidental release may not cause an immediately measurable effect. Chronic releases are limited through a calculated statistical analysis of possible effects to a population of individuals. These events could occur randomly in any population of individuals. It is thought that, as a radiation dose to a population increases, the probability of an increased distribution of the effect is increased. To prevent or limit an increase in these stochastic effects, release rates above certain levels are considered accidents. Accepted probabilities of stochastic effects have been determined and defined by DOE in the 5400 series of DOE orders. These acceptable probabilities describe, as a consequence, an total effective dose equivalent (TEDE) allowed for public and occupational doses. Normal operation has been defined as a dose to an individual member of the public as being no greater than 10 mrem/TEDE through the airborne pathway (i.e., a stack release, fugitive emissions, etc.) in any 12-month period. A dose of 100 mrem/TEDE through all pathways is considered to be normal. The 100 mrem/TEDE through all pathways can be exceeded for some years with the assent of EH-1. This temporary increase shall not exceed 500 mrem/TEDE in any given year, and the dose, when averaged over a lifetime, does not exceed the primary standard of 100 mrem/TEDE.

Risk assessment commonly defines risk with the following formula:

$$\textit{Probability} \times \textit{Consequence} = \textit{Risk}$$

This formula could be restated in regard to radiation exposures as:

$$\textit{Probability} \times \textit{Effective Dose Equivalent} = \textit{risk}$$

This formula is expressed in terms of a calculated individual risk to stochastic health effects. The individual risk accrued during a 70-year lifetime for a population of individuals shall not exceed 10^{-6} and the highest individual risk within that population shall not exceed 10^{-4}. The limit is placed upon the product of the equation. Therefore, if the probability is great enough, the committed effective dose calculated over a 50-year or 70-year lifetime could exceed the limit through repeated events. For these reasons the limits, imposed by DOE Order 5400.5 and defined as accidents in DOE Order 6430.1A and occurring during any single given year, are well below any measurable consequence over any time period. There is evidence to suggest that these limits, if exceeded repeatedly, could cause effects within a large population of exposed individuals. They are considered individually to be abnormal releases but, if repeated over a given period, the total lifetime effective dose is increased, and this increase in risk has been associated with an increase in lifetime health risks (i.e., cancers, etc.).

More sophisticated equipment and instrumentation is required when the risk, as determined by the effective dose, is increased. The greatest consideration is given to that equipment installed with a primary function being to prevent or mitigate the most severe accidents. A graded yet conservative approach to instrument design and function is applied at the ICPP. These features are further discussed in section 1.2.1 below and chapter 11.

1.2.1 Classification of Environmental Monitors

The Department of Energy has, through DOE Order 5480.23[5] and DOE Standard DOE-STD-3009-94,[6] established a graded approach to safety analysis requirements. This approach is applied in the determination of requirements for accident monitoring. DOE Order 6430.1A references accidents as being beyond the limits of DOE Order 5400.5. DOE Order 6430.1A lists six characteristics used to identify safety class items. In a memorandum by the DOE HQ Office of Nuclear Safety, the DOE further specified that, in regard to environmental monitors, the "term 'required' in this sentence shall be interpreted to mean: identified as a requirement in the approved Safety Analysis Report (SAR) and implemented by a technical safety requirement (TSR)." The memo continues, "The lack of designating an item as Safety Class does not diminish the need for implementing appropriate standards for all components, systems, and structures in the facility."[7] In other words, the need for a safety class monitor is determined by the safety analysis. The design and operability requirements are also determined by the safety analysis.

At the ICPP, criteria used in evaluating the features "required" for environmental monitors are determined by the following:

1) The consequences of the design basis accident (DBA) for the processes involved.

2) The ability to terminate potentially hazardous processes should the monitor be placed out-of-service.

3) The ability of the monitor to provide an indication of failure of the confinement barriers.

Based upon the limits established in DOE Order 5400.5, a release is considered "unusual" if it exceeds the limits for normal operation. Such a release can occur chronically or over a relatively short period of time. In terms of mitigation, stack instrumentation is an effective tool to mitigate the consequences from a chronic release. Mitigation at the source for an acute release is less likely; however, detection of the event and response to the event will aid in the mitigation of consequences in the field.

The safety analysis describes conditions of unusual events and accidents. The functions of monitors and equipment used to prevent or mitigate these conditions are described in the analysis. These preventive or mitigative functions are then implemented by design or procedures to ensure that the requirements are met. If monitoring must be provided during certain process activities, the activity can be provided with continuous monitoring, or it can be procedurally controlled to reduce the probability or the consequence. Continuous monitoring is required to track a chronic release or to provide detection for an unusually high acute release. The release point would be classified as requiring a safety class monitor and is subject to higher design or more detailed procedural control to provide the required functions described in the safety analysis. These important functions are described in a technical specification written according to the provisions of DOE Order 5480.22.[8]

The actual design of the monitor and sampling equipment is determined by utilizing a graded approach to the analysis. All of the necessary functions determined in the safety analysis are applied in each instance. These functions must be provided through the DBA, and nonsafety class SSCs should not cause its failure, etc. The need for redundancy and special power supplies is determined by the safety analysis. A system may not have to be provided with full and complete redundancy nor with state-of-the-art redundant electrical supply systems if the safety analysis determines that the necessary capabilities of the monitor are provided without the addition of these features. If, during a power outage, a process can be terminated and the potential for an accident eliminated, the assurance of uninterruptible power is not required. Likewise, total redundancy (two separate and independent monitors) may not be required if the TSR provides for other mechanisms to mitigate or prevent the release (mandatory cessation of process activities, etc.).

If the failure of a safety class monitor will cause a process to be terminated and there is a justification that the process cannot be easily terminated or the cost of termination is prohibitive, then further design enhancements can be used to ensure that the necessary capabilities of the safety class monitor are provided. Increased redundancy, uninterruptible power supplies, etc., may be utilized to ensure that the monitor provides its service through the DBA and that operational requirements are satisfied. This graded approach provides operational flexibility without compromising any safety consideration.

Safety class monitors in this section of the PSD are analyzed according to these criteria. When systems are described as not in full compliance with all of the design functions of a safety class monitor, safety is nonetheless provided in the technical specifications or TSRs for that airborne release point.

If a consequence driven design is utilized, the intent of DOE Orders 5400.5 and 6430.1A is satisfied with a graded approach up to a 500 mrem/TEDE in the public domain. This provides optimum safety considerations, results in a cost savings through the avoidance of installing an over-designed monitoring system that is not justified by the consequence, and ensures that sufficient monitor reliability is provided for post-accident detection/monitoring requirements.

Post-accident monitors also provide a verification of the continued function of the final barrier to a release. Credit is taken in the SAR for the ability of the monitor to detect failures in the final containment barrier (HEPA filters) without the challenge of an additional failure.

The graded approach takes into consideration the consequences from an accident where the final barrier is compromised and an additional challenge is presented, i.e., failure of a process vessel, fire in a contaminated system, etc. The consequences from these events and the ability of the monitor to detect, limit, and mitigate the event are considered. Any unusual release greater than the limits for normal operation are considered to have potential consequences to the public and the environment. Any monitor used in these locations then is classified at the ICPP as a safety class SSC and is subject to higher standards of design or more detailed procedural controls. As described above, it may not be necessary to provide all of the features which have been associated with other safety class SSCs in order to provide the necessary functions of the safety class monitor.

If the primary consideration for the design and installation of a piece of equipment or a system is to limit the consequences of an accidental release to levels described in DOE orders, and if that equipment is required to provide that function, the equipment is considered installed for safety purposes and is assigned a safety classification that may be either safety class or SS. This is true even though the equipment is normally used for other purposes. For example, a stack monitor may be used to sample and record normal environmental releases. If an abnormal release within that system could cause an accident, as defined through safety analysis, the monitor is considered a safety class instrument. If the worst-case accidental release is inconsequential from a safety consideration, the monitor is not a safety class monitor.

Safety class equipment and components are those items that are required for safety purposes only and safety is the primary consideration in their selection. Equipment used only to record chronic releases or to ensure as low as reasonably achievable (ALARA) principles is not assigned safety classification. Equipment already determined to be required for safety purposes may, however, be used for other purposes as required. Safety classification is discussed further in section 11.

This is a more restrictive definition than may be used at other facilities where the determination for safety classification may be all or none. The all-or-none concept tends to argue that nothing is safety class unless the consequence to the public is 500 mrem/TEDE or greater. At the ICPP, a graded approach to the design of the monitor is applied. This graded approach to the analysis prevents compromising safety considerations identified in the SAR that could cause airborne releases between normal operating limits and the 500 mrem/TEDE limit.

Minimal settings for effluent monitoring instruments are established to detect increased rates of discharge at the lowest range practicable while preventing false alarms. These settings may be orders of magnitude below a release that would cause a safety concern. Because of this, alarm settings are frequently not established as safety limits but as operating limits. Actions taken to prevent exceeding an operating limit are sufficient to prevent or mitigate the consequences long before a situation becomes an urgent safety consideration.

2. SUMMARY SAFETY ANALYSIS

This section gives a summary of the results of evaluations of various safety aspects related to airborne waste management at the ICPP. The items identified that influence the design of the airborne management systems are discussed in more depth in the following sections. Those factors having a major effect on ICPP operation are discussed in this section. The following discussions include general considerations for all ICPP airborne effluent management and control policies as well as specific areas where major effluent management policies are maintained. Each facility or process has its own description and safety analysis contained in other sections of the PSD. These areas are treated generically in this section as required. Specific descriptions and policies are included in this section for major treatment areas and for facilities designed solely for the purpose of the management of airborne effluent (i.e., CPP-649, CPP-604, CPP-756, etc.).

2.1 CONCLUSIONS

The equipment and systems used to control and mitigate releases to the environment are not radioactive processes themselves. They are designed to provide added assurances that normal operational releases of airborne materials are within applicable regulations and DOE orders. The equipment also functions to mitigate accidental releases occurring in process systems.

The airborne waste management systems are designed to capture and contain radioactive materials that would otherwise be released to the environment. Because the material is collected and concentrated in filter media, the concern is an event that can release the collected material over a short period of time. Administrative controls and design considerations are devoted primarily to reducing the probability of these occurrences while simultaneously reducing the consequences of the event. The product of these two factors (probability x consequence) defines the risk from the event. The systems installed to mitigate environmental releases of radioactive materials are essentially in place to reduce the consequences from other accidents. A primary concern in the design and operation of these systems is that they are able to provide mitigation and monitoring through the accident scenarios described for the systems. Most active process off-gas streams are serviced by two stages of HEPA filtration. Each facility at the ICPP has its own unique ventilation and/or process off-gas system. There are several designs for the various Calcined Solids Storage Bin Sets. Each facility and/or process has an SAR included as a section of the PSD. Complete descriptions of these designs and their operation can be found in these facility-specific SARs.

While the ventilation systems normally require only a single stage of HEPA filtration, some systems are provided with two stages. Prefiltering is done using nontestable filtration upstream from the final bank. The identified postulated abnormal occurrences (PAOs) and accidents define the safety envelope for airborne waste management.

2.2 SITE ANALYSIS

A complete analysis and description of the ICPP in relation to the impacts of natural phenomena can be found in the Idaho Chemical Processing Plant Safety Analysis Report (ICPP SAR), Part I, "General Safety Analysis," Chapter 1, "Site Characteristics."[9]

2.2.1 Site Characteristics Affecting the Safety Analysis

Many components of the ventilation and off-gas systems at the ICPP were not designed to the current seismic criteria. Some components have not been structurally analyzed for natural events, such as seismic, wind loading, etc. Failure of these items due to natural phenomena would not cause an unacceptable risk to off-site populations, but could pose a risk to personnel within the ICPP perimeter. The failure of the Main Stack due to seismic activity is the worst seismic event postulated for the airborne effluent systems. Stack failure, by itself, will not result in radioactive releases that would cause a dose in excess of normal operating limits. The stack was recently cleaned, and an internal radiation survey found it still contained measurable levels of radioactivity. The radioactive material is encapsulated in interior layers. The stack has been upgraded, and older contamination is sealed under stainless steel liners and additional layers of concrete. The greater risk is from personnel and structures being struck by debris. Should the stack destroy other structures from its collapse, quantities of radioactive materials other than that in the stack could be released. Loss of confinement in a high-level liquid waste tank could occur. This loss is evaluated in PSD Section 4.2, "Aqueous Liquid Waste Management."

In the event of seismic failure of any component in the airborne management system, administrative emergency procedures would define the correct level of response (alert and notification level) to the event. The stack has been hardened to withstand a seismic event that produces 0.12-g horizontal acceleration. An earthquake of this magnitude has a probability of E-03/y at the INEL. The seismic event beyond 0.12 g would have a probability E-03/y to E-04/y (failure occurring somewhere beyond 0.12 g).

2.3 NORMAL OPERATIONS

2.3.1 Radiological Impact of Normal Operations

The radiological impact during normal operations is low and results mostly from maintenance activities on the system. Ventilation and off-gas systems are designed to collect and confine radioactive materials from other processes. Normal operation of these systems does not cause an increase in risk. These systems remove materials that would otherwise be released through normal operations. Failure of these components can, however, cause the entrained material to be released over a shorter period of time. Resulting TEDEs to personnel are orders of magnitude below the limits imposed by DOE/EH-0256T. Refer to section 8 for more detail.

2.3.2 Nonradiological Impact of Normal Operations

Normal operation of the airborne waste management systems does not produce an increased risk to personnel from industrial hazards. Maintenance of equipment, storage of materials, work practices, etc. are covered in other individual sections of the PSD and the Industrial Safety

Manual for the ICPP.[10] Fans, motors, etc., are guarded. Toxic or hazardous materials are confined within the system. Access to those areas is administratively controlled.

2.4 ABNORMAL OPERATIONS

2.4.1 Radiological Impact of Abnormal Operations

Abnormal occurrences and their consequences are discussed in section 9. The consequences from these types of events are relatively low. Due to the practice of providing multiple confinement barriers, the airborne waste system is designed to retain the radioactive effluent within the system. It would require multiple failures of confinement barriers to release radioactive materials to the environment. Personnel errors during maintenance activities can cause limited releases inside of controlled areas. These spills would normally be retained within the secondary confinement barrier.

Releases have occurred when operational upsets have caused the generation and release of materials for which the system is not designed. The installed equipment is designed to remove particulate materials that are the principal dose constituents in the ICPP effluent. Volatile radionuclides and noble gases are not removed. These constituents of the effluent do not normally constitute a significant fraction of the on-site or off-site dose. Abnormal events, however, have caused the release of more than normal amounts of ruthenium and antimony. These nuclides are process specific and controls to prevent or limit their release are to be found within their respective sections of the PSD. Central release points, such as the Main Stack, have no specialized equipment for the mitigation of these releases. Special equipment or procedures are provided for the particular process which produces the unique effluent nuclide. Controls against the release of ruthenium, for example, are found within Section 8.2 of the PSD, which describes the design and operation of the NWCF.

2.4.2 Nonradiological Impact of Abnormal Operations

As is the case with radiological materials, hazardous or toxic materials can be released from the waste management systems as a result of maintenance activities on the equipment or sampling apparatus. This could result in a lost time accident for exposure to some of the more irritating constituents of the effluent. It is possible that larger leaks of hazardous materials (i.e., NO_x) could occur. A major leak of NO_x into a room or other confined area could result in deaths among the persons exposed.

2.5 ACCIDENTS

Consequences from various accidents are reported in section 9. Accidents within the airborne waste management systems are of the type that can cause failures of the final confinement system. The worst accidents of this type involve fires which destroy the final filters and release the contained radioactive material over a short period of time. Other accidents can occur in which toxic materials can be released into occupied areas. These could occur because of personnel errors or natural phenomena. In ventilation and off-gas systems, an accident releasing NO_x could cause ICPP personnel exposures in excess of values immediately dangerous to life or health (IDLH). Releases of this nature would not endanger the public.

All accidents considered result from or cause a violation of the primary [process off-gas (POG) system] or secondary confinement (plant ventilation system) and include the following:

1) A fire upstream from the CPP-756 prefilter that causes secondary fires in the vault and on the 104 filters of CPP-649.

2) A flood resulting in water collecting in the CPP-756 prefilter vault.

3) A seismic event resulting in failure of the duct from CPP-601 to CPP-649.

4) A seismic event resulting in failure of the Main Stack, CPP-708.

5) An NO_x release exposing one or more workers to levels in excess of the IDLH causing injury or death.

It would require multiple failures to violate the primary (process vessels and lines) and secondary confinement areas. A single initiator (an earthquake of sufficient magnitude) could cause these simultaneous failures.

3. SITE CHARACTERISTICS

The ICPP is remote from major population centers, waterways, and transportation routes. The INEL has no permanent residents. Ingress and egress of site personnel for performance of their duties and of visitors on official business are closely controlled. No casual visitors are permitted.

The ICPP is located 42 miles west of Idaho Falls, Idaho, near the southern boundary of the INEL. The exact geography, demography, hydrology, climatology, etc., can be found in the ICPP SAR, Part I, Chapter 1.

4. PRINCIPAL DESIGN FEATURES

Process off gas at the ICPP (CPP-601) is composed of vessel off-gas (VOG) and dissolver off-gas (DOG). These two flows are defined by the final treatment systems resident in CPP-604, CPP-605, and CPP-649. As displayed in figure 3, the final ventilation and process effluent cleanup systems, collectively known as the atmospheric protection system (APS) has two major sides exhausting into the Main Stack. The side shown to the left of the stack in the figure is the ventilation side of the APS (ventilation APS). The opposing side to the right of the figure was designed to handle more corrosive process and vessel off gas and is known as the POG APS. Each of these systems has a variety of subsystems that join into the single effluent stream at the APS facility. When this section refers to POG APS, it is referring to the final filtration systems for all process gases that are routed to that side of the APS including the VOG systems, NWCF POG, C-cell and E-cell, continuous process modification (CPM) DOG, and others. Other sections of the PSD describe these subsystems for the processes involved. When the ventilation APS is referenced, it includes all systems that are routed through the ventilation side of the APS.

The ventilation APS has the following subsystems influent into that side of the APS. These systems merge (except for E-DOG) before the ventilation APS prefilter (CPP-756):

Ventilation APS

- Ventilation air from CPP-649.
- Ventilation air from CPP-604.
- Ventilation air from CPP-633.
- Ventilation air from CPP-601 (including CPP-602, CPP-640, CPP-627).
- Tank Farm pressure relief valves.

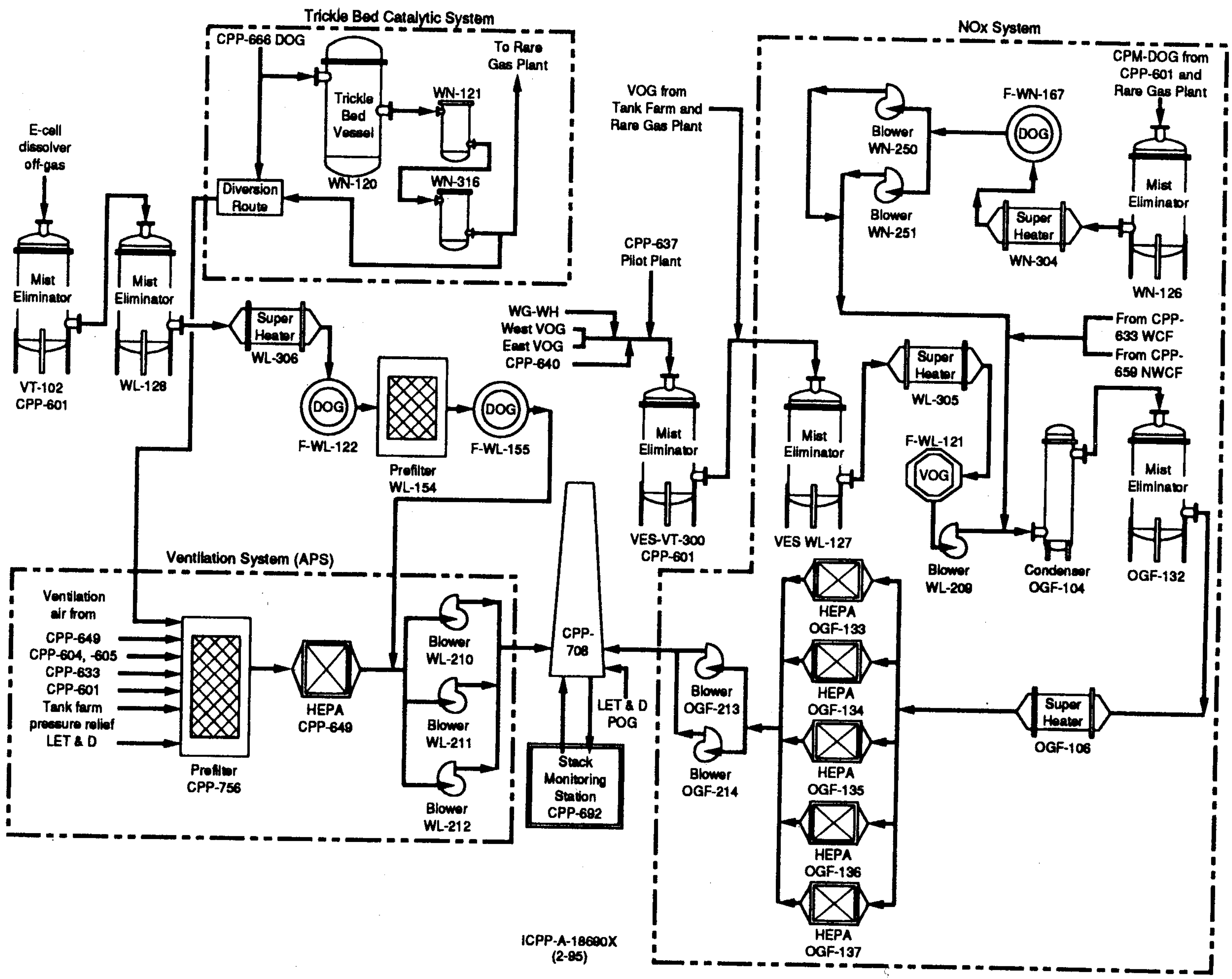


Figure 3. Final Off-Gas Cleanup and Monitoring Flowsheet (CPP-604, CPP-605, CPP-649, CPP-708, and CPP-756)

- Liquid effluent treatment and disposal (LET&D) ventilation.

- E-cell dissolver off-gas (E-DOG) also is routed to the ventilation APS; however, it is downstream from the APS final filters. Essentially, E-DOG has a separate APS including VT-102, VT-128, WL-306, F-WL-122, F-WL-155, and F-WL-154. After passing through this system, E-DOG is brought into the ventilation side between CPP-649 and the blowers. E-DOG has not been used for several years and is currently valved out.

The ventilation APS exhausts the secondary confinement areas in CPP-601, CPP-602, CPP-627, and CPP-640. These areas include the cells and cell off-gas systems, the sample stations and sample off-gas systems, access corridors, operating areas, laboratories, decontamination test area, etc.

The POG APS serves to provide final filtration for process off-gases that can be more highly radioactive and may contain corrosive ingredients that can damage ordinary systems. The POG APS provides, in CPP-604, the final stage of filtration for the following POG systems:

POG APS

- CPP-601 Area.
    - WG-WH vessels (WG-100, -101; WH-100, -101).
    - West and East vessel off-gas (VOG).
    - CPM DOG.
- CPP-640.
- CPP-637 pilot plant.
- VOG from Tank Farm, Rare Gas Plant, CPP-604 [process equipment waste (PEW) VOG].

- CPP-633 (WCF and WCF calcined storage bins).

- CPP-659 (NWCF POG).

The major design features of the systems that route through the POG-APS systems are as follow:

1) Each off-gas system is enclosed from the source vessel to the APS where the gas mixes with other gases prior to filtration and release to the atmosphere.

2) The integrity of the barriers between the off-gas systems and the ventilation systems is preserved by designing the systems for the environment in which they serve and to preserve the confinement barriers between the systems.

3) Each off-gas system is operated under a vacuum prior to the initial stage of filtration, so that if the interface is breached, air leakage is into, rather than out of, the system. Short sections of an off-gas or ventilation system may be pressurized downstream of blowers or jets. This equipment, blowers and jets, is usually located downstream of filtration. Pressurization of ducting downstream of filter media is not usually a problem. Brief blower transients may, however, cause short reverse pressure pulses in interfacing systems. NWCF transients have caused pressurization of systems within the WCF upstream of filter systems. Localized pressurization in contaminated ducting can result in contamination releases from systems that are not designed to operate at positive pressures. The contamination so released is retained within the secondary confinement.

4) ***Each normally radioactive off-gas system is filtered by a HEPA filter prior to release to the atmosphere.*** Some streams are additionally passed through prefilters, condensers, mist eliminators, and superheaters, all of that function to remove water and other contaminants that may cause the failure of, or

in other ways, compromise the integrity of the final filter system. These systems (upstream from the HEPA filters) are designed to remove, as liquid waste, entrained condensates and larger particles from the effluent stream. Most of the remaining particles are removed by the HEPA filters. Operability requirements for this equipment may vary according to process.

Ventilation systems that provide the secondary confinement for process areas have the following design feature controls:

1) ***Ventilation systems are designed to provide flow from areas where the contamination potential is low into areas where the potential is greater, i.e, from occupied process control areas into process cells or from occupied laboratory rooms into hoods and gloveboxes.***

2) ***Before release from the stack, the flow passes through a prefilter and at least one final HEPA filter.***

3) Laboratory hood systems use blowers that withdraw contaminated air from hoods and gloveboxes. Two stages of HEPA filters are included for radioactive effluent from laboratory hoods and gloveboxes as required.

Airborne effluent systems utilize remote fittings, and bag-out capabilities where required. The more highly contaminated filters are located in shielded cells. Administrative controls limit the amount of radioactive material that can collect on a filter and specify ranges of acceptability for pressure drop across filter banks.

Systems currently in use at the ICPP were evaluated against the original criteria and against current criteria. In examining current criteria, the following documents were used to compare our current systems with those that would be designed and built today:

1) DOE Order 6430.1A, "General Design Criteria," April 6, 1989.

2) DOE-ID Architectural Engineering Standards, revision 17, December 1994.[11]

3) UCRL-15910, Design and Evaluation Guidelines for Department of Energy Facilities Subjected to Natural Phenomena Hazards, June 1990.[12]

4) ICP-1082, UC-10, Final Safety Analysis Report for the Atmospheric Protection System, P.I. Nelson, June 1976.[13]

5) Ralph M. Parsons Co., Refurbishment of the ICPP Main Stack, Job Number 6-154-13, March 13, 1983.[14]

6) American National Standards Institute (ANSI), ANSI N13.1-1969, "The American National Standard Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities," February 19, 1969.[15]

7) Nuclear Regulatory Commission (NRC), Nuclear Regulatory Guide 3.18, "Confinement Barriers and Systems for Fuel Reprocessing Plants," February 1974.[16]

8) NRC, Nuclear Regulatory Guide 3.20, "Process Off-gas Systems for Fuel Reprocessing Plants," February 1974.[17]

9) NRC, Nuclear Regulatory Guide 3.32, "General Design Guide for Ventilation Systems for Fuel Reprocessing Plants," September 1975.[18]

10) ANSI and American Nuclear Society (ANS), ANSI ANS-11, "Design Guides for Radioactive Material Handling Facilities and Equipment," 1988.[19]

Two areas of concern were discovered in the evaluation. These being that the prefilter vault located in CPP-756 has been altered from the original design, and that the seismic criteria upon which the design for many of the ventilation and off-gas components was based are less demanding than criteria today. Some components of the off-gas or monitoring systems would be built to a more strict set of criteria today. Some components, monitoring systems, would be classified as safety class components. Others that could cause the failure of safety class items would be evaluated with that concern. This does not imply that operation of these facilities creates an unacceptable level of risk but that methods other than design must be considered to control the risk to levels commensurate with current criteria.

The alteration of CPP-756 from the original design and the other concerns are discussed in section 9 as contributors to PAOs and accidents.

4.1 COMPARISON OF SYSTEMS TO CRITERIA

4.1.1 Introduction

A principal objective in the design of nuclear facilities is to prevent the uncontrolled release and dispersal of radioactive materials. These materials are ingredients of process fluids, process solids, and ventilation gases. Release of radioactive materials is controlled by one or more individual confinement barriers and systems that successively restrict releases of radioactive material to the environment or into areas normally occupied by plant personnel. Ventilation systems, process vessels and off-gas systems, and the building structure itself provide the multiple barriers against such releases.

For monitoring purposes, the DOE has provided direction in DOE Order 6430.1A and in DOE/EH-0173T.[20] These two documents provide a graded approach to the level of concern for monitoring equipment. This graded approach recognizes that the consequences from differing accidents within a facility require differing design concerns. The objective is to provide final confinement and monitoring capabilities at a level commensurate with the risk from the failure of those systems when the processes upstream are threatened.

For monitors and samplers there are two significant levels of concern. These levels are associated with the maximum dose that can be attributed to that release point from an accident in the facility serviced by the ventilation or POG system. If an accident within the facility has the potential to initiate an atmospheric release in excess of the release allowed for normal operations per DOE Order 5400.5, facility design provides attenuation features for those accident conditions (DOE 6430.1A, section 1300-1.4.2). Attenuation features include the barriers and the means to monitor the effectiveness of those barriers. DOE Order 6430.1A, section 1300, states that safety class systems include instruments that are required to monitor the release of radioactive materials to the environment during and after a DBA.

The intent is to provide criteria that ensure that barriers function to provide confinement of radioactive or otherwise hazardous material. Sampling and monitoring for safety purposes are given a high level of importance in the criteria. Also monitoring is required to provide compliance for environmental reporting of normal operational releases. However, monitoring for safety purposes is provided to ensure a timely alert to unusual releases, the failure of final confinement, and the ability to collect data to quantify a release. Exhaust and monitoring systems providing these functions must be highly reliable and designed to provide their safety function through design DBAs. Monitors installed prior to these requirements are not required to provide all of the functions of more recent installations. Where the newer criteria are not met, the ICPP and the DOE have provided additional backup capability that will provide the required data for post-accident evaluation. Data from these instruments and sampling programs is not available in realtime.

In the event of the failure of a safety monitor, accidents would be detected by other monitoring systems in a "near-real-time" fashion and preliminary analysis would provide reasonable data to determine a level of response. Absolute quantification of releases would be delayed until environmental samples, site dosimetry, and laboratory analysis could be completed. The criteria also provide that, with a properly designed facility, failures within a single system will not compromise the integrity of the confinement. In addition, initiating events that are external to the facility should not cause general failures that lead to the loss of confinement.

A design providing compliance with all these concerns and mitigation or prevention of more severe accidents could be considered an engineered safety feature (ESF). There are no ESFs within the ventilation or off-gas systems. There are, however, safety class and safety significant systems or components.

Current criteria have resulted in the classification of the Main Stack monitor as a safety class monitor and the NWCF monitor as being safety significant. A safety significant monitor is required for worker safety or for components whose preventive or mitigative function is a major contributor to defense in depth.

The Main Stack monitor is isokinetic and redundant in all areas except for electrical power supplies. Failure of nonsafety class components in the ventilation or off-gas systems may cause the monitor to not perform its function.

All ICPP airborne effluent monitors are subject to single failures. These failures are due to natural phenomena hazards (NPHs). The failure has the same probability as does the NPH event. One failure is associated with seismic events. Another failure can occur in the immediate notification to operators of failures resulting in a loss of data to the distributed control system (DCS), i.e., a total loss of power, including uninterruptible power supply (UPS). Complete loss of power due to a single failure or an NPH event is considered an highly unlikely to incredible accident.

Loss of monitoring capability would, in most cases, not cause an increase in the accidental release. Upgrades to these systems consider these conditions, and designs are approved on a cost-benefit basis. Monitor upgrades at the ICPP have been evaluated against these criteria and have been approved based upon these evaluations. Upgrades, completed after these evaluations and approvals, provide systems as close as practical to current requirements for new installations.

Requirements for other monitors are determined by other sections in DOE Order 6430.1A. For example, if the atmospheric release point (ARP) releases fission products during normal operation of the process, and a potential release from the ARP during unusual or accident conditions can result in a dose that exceeds 0.1 mrem/y, the monitor must be isokinetic and should be redundant, but it is not safety class. The FAST stack monitor satisfies these requirements. Redundancy is not necessarily required if the process can be easily terminated should a single monitor fail.

Environmental and safety class monitoring requirements were evaluated by a task team and reported.[21] Figure 4 summarizes the conclusions of that report. The team evaluated the differing requirements of the Environmental Protection Agency (EPA) and the DOE to determine the level of concern for airborne effluent monitoring. DOE requirements are based upon a concern for the reliability of the monitoring function. It is important that releases (particularly accidental releases) not go undetected or unmonitored. Therefore, if the consequences of the accident approach or exceed the limits set forth in DOE Order 5400.5, then instrumentation to monitor and record that event must be highly reliable. The ICPP ensures this reliability by operating redundant systems on these ARPs. The EPA does not regulate accident situations, rather they are more concerned with the detail of the data over normal operational periods. The reporting requirement for EPA purposes requires sampling somewhat less than 100% of the time. They do, however, require greater detail in the sampling and monitoring for individual nuclides. For these reasons, the ICPP has installed monitors and samplers to quantify certain nuclides which contribute more than 10% of the dose at the site boundary. This monitoring is, however, not essential to maintaining the safety envelope.

Another analysis was completed using computer codes as specified in DOE Order 5400.5 and the Code of Federal Regulations (CFR), Title 40, Part 61,[22] for normal operational airborne releases.[23] The report concluded that the effluent monitors at the FAST stack and the Main Stack provide compliance with environmental monitoring requirements for normal operation. The report also identified nuclides that, during normal operations, contribute more than 0.1 mrem in a year.

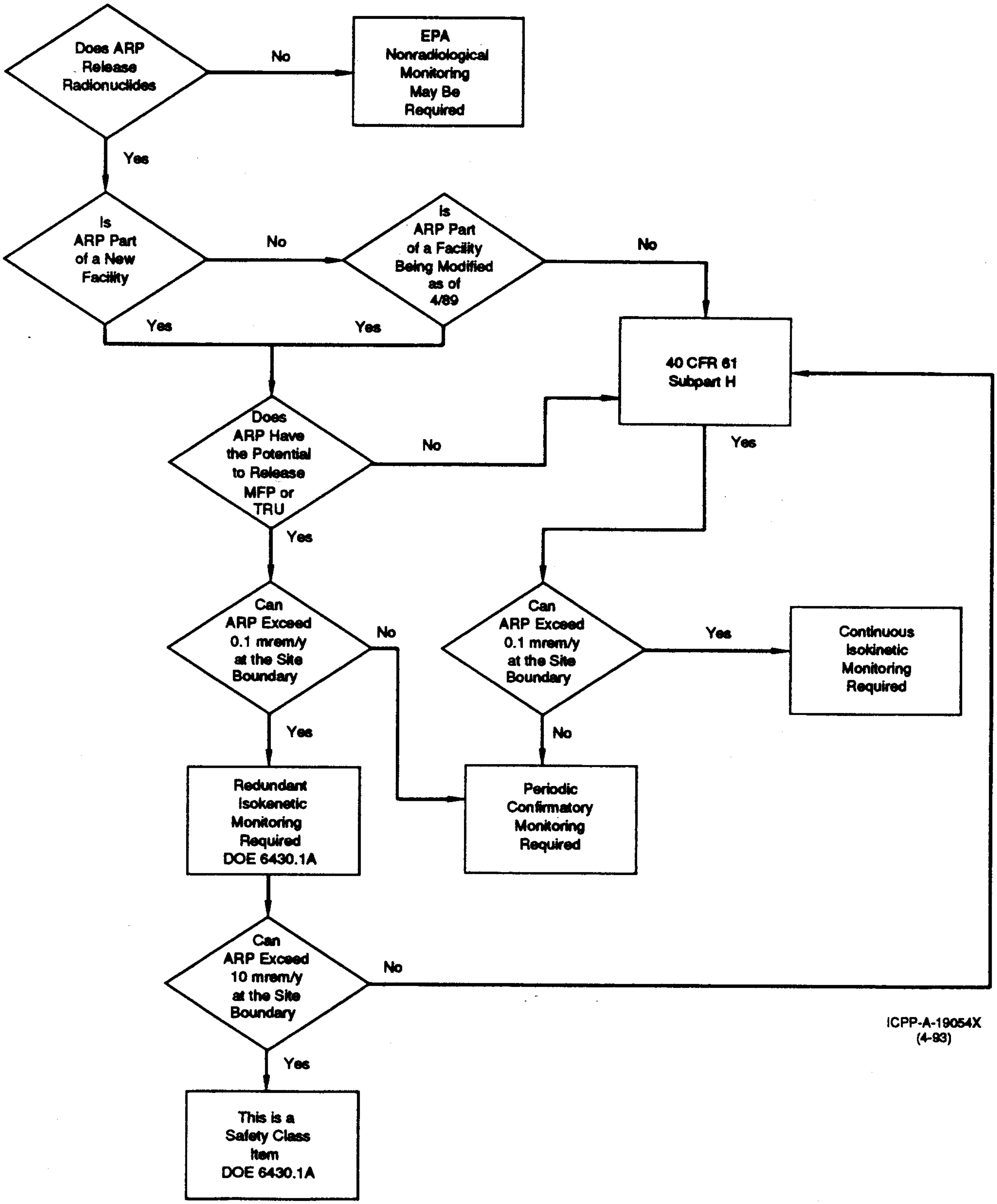


Figure 4. Logic Flow Diagram for Monitoring Requirements

Environmental requirements are distinct from those which the ICPP uses to establish the safety envelope. These distinct requirements are melded into procedures for the operation of ICPP process and monitoring systems. The safety envelope describes situations in which the normal operational conditions might be exceeded. Controls are described that may reduce the probability of or the consequences from these events.

4.1.2 Criteria of Importance to Safety

The following requirements are applicable to all parts of the ventilation systems, POG systems, and monitoring systems. The ways in which these requirements are met differ only according to the detail (levels of redundancy, emergency power, etc.) required and the age of the facility. The detail is normally based upon consequences from failures in the system. This is usually measured in terms of potential doses occurring as a result of DBAs. The DBA may vary from system to system. The Main Stack, for example, is not considered a safety class component of the ventilation system. Failure of the main stack may, however, result in the failure of safety class systems. As such, the requirements for the Main Stack are more detailed than those which prescribe designs for less important components. Components such as the stack (if built today using current criteria) must survive the DBA or fail in such a way that SC SSCs will not be disabled. In cases where the design cannot be upgraded, administrative controls are used to control the level of risk.

There are general requirements that all systems and components must meet. Again these requirements are graded according to the consequences of component failure, those consequences being determined by safety analysis. Table 1 provides a comparison and commentary of criteria important to safety.

4.1.2.1 Seismic Criteria. Facility hazard is determined by ICPP procedure WE-31, which implements UCRL-15910. This document determines the resistance of a facility against seismic events based upon a hazard categorization. The hazard category is determined by the consequences

Table 1. System Comparison to Criteria

System	Safety Class Monitor	Radiological and Process Monitoring	Comments
New Waste Calcining Facility (NWCF) process off-gas (POG)	yes	Monitoring at Main Stack	Applies to components of POG resident in NWCF. Main Stack monitor for this process is not qualified due to lack of redundant or emergency power supplies, failure of (nonsafety class) stack causes failure of sampling equipment. Not evaluated for natural phenomena hazard (NPH) beyond Uniform Building Code (UBC).
NWCF ventilation	yes	Monitoring at NWCF stack	Monitor is not qualified for safety class function. Monitor is not designed per American National Standards Institute (ANSI) standards. Not evaluated for NPH beyond UBC.
Atmospheric protection system (APS) ventilation	yes	Monitoring at Main Stack	Original design of CPP-756 prefilter vault significantly modified affecting fire resistance protection for final filters. Outdoor portions of ducting not evaluated for design basis wind (DBW) or seismic resistance. Main Stack monitor, while redundant, is not up to criteria for safety class for reasons listed for #1, above. Failure of nonsafety class SSCs will cause failure of monitor. Not evaluated for NPH beyond UBC.
APS POG	yes	Monitoring at Main Stack	Each process has two stages of testable high-efficiency particulate air (HEPA) filters. Not evaluated for NPH beyond UBC.
FAST ventilation	no	Monitoring at FAST stack	This ventilation system will no longer be used as exhaust point for fuel dissolution. Future effluent will be insignificant for radionuclides. Design basis accident (DBA) is low hazard at nearest site boundary.
Remote Analytical Laboratory (RAL) ventilation	no	Monitoring at RAL	RAL monitor is not redundant. DBA is low hazard at nearest site boundary.
Irradiated Fuel Storage Facility (CPP-603)	no	Monitoring of dry storage ventilation. Monitoring of basin area (wet storage) with CAMs.	Monitors, filtration, stack, etc., were designed to detect leaks in stored fuel (primary confinement monitor). Heating, ventilating, and air conditioning (HVAC) system is designed as clean system. Accident conditions would dictate a more modern, redundant (but not safety class) system. Accident of concern is criticality. Stack height is insufficient to prevent radioactive cloud from accident conditions from re-entering building into occupied areas.
Denitrator product gloveboxes	no	Exhaust to roof of CPP-602. No monitoring provided. Can draw a sidestream sample.	Accident of concern is criticality. Other monitors provide alert to accident. Stack height is insufficient to prevent a radioactive cloud from re-entering building into occupied areas. Denitrator is currently being decontaminated and decommissioned.
Laboratory hoods and exhaust systems	no	Exhaust to roofs of facility. No active monitoring; side streams can be sampled.	These are low hazard operations. Design basis accidents produce low hazard level consequences.

Table 1. (Contd.) System Comparison to Criteria

System	Safety Class Monitor	Radiological and Process Monitoring	Comments
Main Stack	yes	Stack is exhaust point	Stack is not qualified seismically for failure to safety-class level. Stack collapse could cause failures of other safety class items.
Main Stack Monitoring Building	yes	Sample gases are returned to Main Stack	Building failure may result in loss of sampling and monitoring functions. Building is not safety class. Equipment inside building is safety class, but is not supplied with safety class uninterruptible power supply (UPS) or emergency power.

from failures and accidents within those facilities. If the hazard from these accidents can cause accident consequences in excess of the limits imposed by DOE Order 5400.5, monitoring, ventilation, and off-gas systems become safety class systems. For airborne monitoring situations, monitors that may be needed to operate during releases in excess of those occurring from normal operations are designated as safety class monitors. These are monitors in which an abnormal release could cause a dose in excess of 10 mrem/y TEDE based upon the source term available for release. Safety classification for other equipment is judged according to different criteria. The criteria are, however, also based upon off-site dose consequences. The DOE order provides guidelines against the release of materials that can cause consequences beyond those from normal operations.

Monitoring, ventilation, and (in some cases) POG systems may require resistance beyond their hazard category. Because these items cannot generally have failure consequences exceeding the guidelines of UCRL-15910, they may be considered to reside in a "low hazard" facility use category as defined in UCRL-15910. These facilities must be designed such that they cannot fail in a way that causes the failure of safety class equipment. These systems must, however, provide their safety function through a DBA that occurs upstream in a different process or facility. Therefore, while the equipment may be located in a low hazard facility use category (i.e., an instrument building housing the electronics for a stack monitor), the instruments and electronics must survive the accident if they are required to monitor releases greater than those stipulated in DOE Order 5400.5.

The Main Stack serves as the final component for several ventilation and POG systems. The stack has been upgraded twice in the past. These upgrades qualified the stack to survive a 0.12-g earthquake. This degree of hardening does not satisfy current requirements. The stack also may be a potential threat to other systems that can be damaged or destroyed by stack failure.

4.1.2.2 Design Basis Fire. Within ventilation and off-gas systems there are two types of fire concerns. A fire can occur external to the system and cause system failures through heat, smoke generation, or water injected into the system. Or a fire can be initiated within filter media, causing failure of the filters, release of entrained materials, and possible failures in downstream filter systems. POG systems, because they are totally contained systems, are relatively resistant to the threat of fires external to the primary confinement. Ventilation systems are more likely to be affected by fires occurring in the areas they service rather than in the filters themselves.

These susceptibilities are reflected in the requirements for protection from fires external and internal to the ventilation or POG system. There are many more controls placed upon fire protection for ventilation systems than there are for POG systems. Fires in process areas, cells, operating areas, laboratories, etc., can generate smoke particles, excessive heat, particles of ash or soot, water vapors used to extinguish the fire, etc. Such conditions are not normally found in design basis fire (DBF) scenarios for POG systems.

Some final filters, which could have fires within the filter media, are protected by water extinguishing agents within filter housings. These extinguishing agents should be used only in the event that the consequences from the fire are greater than the consequences accrued as a result of the water sprays destroying the final filter barrier. Filters utilized in final filter configurations should always be of a fire resistant construction and be protected from upstream threats to reduce the need for automatically activated fire protection devices within the filter housings.

The ventilation system coming into CPP-756 (the prefilter vault) was installed with smoke detectors, temperature sensors, a bypass damper, and an automatic fog spray to cool the air and wash particles and smoke from the stream, which would plug the filters. This system provided near conformance with Regulatory Guide 3.32. If the system had been used, however, the moisture resulting from activation of the fire suppression systems would likely have destroyed the downstream HEPA filters. Due to a poor design, the fog system was valved out and put on manual control, and the smoke detectors were taken out of service. Credit was taken in previous analyses for this equipment. Refer to section 9 for an updated analysis.

4.1.2.3 Design Basis Tornado (Wind). Tornado winds with the accompanying pressure differentials are not a threat at the ICPP. There are no recorded incidents of tornadoes within the INEL boundary. The ICPP SAR update[9] to the PSD replaces the analysis in PSD Section 2, which has been canceled, with the currently accepted data indicating there is no tornado risk at the ICPP. High wind velocities can occur, however. Most of the structures are designed to withstand a 95-mph wind. There are duct structures, however, that were designed only to the Uniform Building Code (UBC). Among these is the outside duct from CPP-601 to the APS ventilation prefilter. It is not known if this duct could survive a 95-mph wind or the acceleration from a DBE.

There are also filter housings and filters resident on some building roofs. These normally service laboratory areas or the irradiated fuel storage facility. These filters contain low-level radioactive materials and, while they have not been analyzed as to their survivability, failure of the filter housing due to a high wind would not cause a release from which a dose could be measured at the nearest site boundary.

4.1.3 Summary of Criteria and Assumed Risk of Operations

The most important limiting factor in determining the safety envelope for operation of any facility is the consequence that the operation might have upon the public, the environment, and personnel. Risk factors are determined as the product of the probability of the occurrence times the consequence (usually determined by potential health effects and injuries). The safety analysis function is to describe those risks and to determine the acceptability of the risk based upon DOE orders and standards. Public perception, which is sometimes based upon considerations outside the scope of safety analysis, is not a consideration in the analysis.

The operation of older facilities, which today would be designed and built under newer criteria, is done at an increased risk over that of a newer facility. The risks associated with the operation of such a facility are no greater than they were when the facility was first built and operated, provided that the facility has not been allowed to deteriorate. The comparison of the facility with current criteria provides an analytical tool that can lead to the correction of some conditions and the increased application of controls that can reduce the risks below those originally accepted when the facility was new.

In a nuclear facility where confinement of radioactive materials from the environment is the major concern, the maximum accidents are usually described in scenarios where all of the material present (the source term) is released over a relatively short period of time. These accidents are usually described as DBAs. The DBA is then the accident that normally describes the safety envelope for the facility.

There are criteria against which the DBA is evaluated. These criteria are given in the various documents, DOE orders, etc., that are discussed in this section of the SAR. There is further discussion later in section 9. Consequences and risks are addressed in section 9.

As listed in table 1, certain components of the off-gas and ventilation systems could be determined as less-than-adequate when compared with current design criteria. Continued operation of the systems under these conditions causes an increase in risk from that operation due to an increase in the probability of component failures when compared with newer designs. There is no increase in the consequences from the DBAs. The acceptability of that risk is determined, based upon the product of probability times the consequences from the event.

In section 9, it can be seen that, for the occurrences and accidents that are possible within the off-gas and ventilation systems, the consequences from these occurrences (listed as "severity" in the tables) are, for the most part, relatively minor. In many cases failure of any component results in consequences too low to be measured. Where more current design requirements are not provided, the consequences from occurrences and accidents in these systems are shown by safety analysis to be well within what has been considered to be an acceptable level of risk in other processes and activities at the ICPP.

Consideration has been given in the safety analysis to reduce the risk to levels achieved by newer criteria through the enhancement of requirements applied to the operation of systems and the maintenance of components. Where practical to do so, radiation and contamination limits allowed within off-gas and ventilation systems have been reduced, operation of off-gas and ventilation systems has been better defined to ensure that configuration control for the systems is better maintained, and surveillance of systems has been transferred in many cases from periodic monitoring and logging requirements to real-time distributed control systems with alarms in operating areas.

There are two scenarios of concern in which the risk from the event is identified by safety analysis as being "marginal" (low marginal). This would not be the case if the equipment involved in the accidents were designed to survive the currently evaluated DBA. The probability for these accidents is increased from expected failures in the systems caused by the DBFs or design basis earthquakes (DBEs).

The most severe DBF postulates a fire occurring that causes a release of all entrained material in the CPP-756 prefilter and the CPP-649 final HEPA filter banks. While this scenario cannot be eliminated in any design, the probability for the event could be reduced by providing additional protection for the filters.

The original scenario for the DBF, as published in the previous version of the SAR, used a source term that did not account for the level of contamination currently in the filter. Credit was also taken for fire protection equipment and bypasses that are no longer operational. This equipment cannot be repaired or replaced due to the inaccessibility of the filter (belowgrade, no hatches). The present condition of ancillary equipment is not as described in previous analyses. This altered configuration increases the probability and consequence factors of the risk from a DBF. A secondary fire occurring in the filter from a fire upstream may also be more probable due to the unknown nature of contaminants on the filter media (dust, ammonium nitrate, etc.) and the inability to obtain a sample of the material present in the filter. These detriments are somewhat offset by the following mitigating factors.

The source term used in the scenario is from materials assumed resident within the prefilter media. This term is a result of many years of operation with radioactive effluent being passed through the filter. This effluent was generated from the dissolution of fuel and from releases which occurred during the operation of the Waste Calcining Facility (WCF). A significant fraction of the material present in the filter is assumed to be radioactive material with a high specific activity deposited from an incident at the WCF.

The WCF is inactive and, as such, will not contribute additional process effluent to the off-gas or ventilation systems or filters. The maximum amount of contamination buildup allowed on the downstream filters that may be involved in a postulated fire has also been reduced by requirements provided in the updated safety analysis. Fuel processing is no longer a part of the ICPP mission. The terminated processes will be placed in an inactive status in the immediate future. Once a sweep-down of the CPP-601 processes is complete, the source term currently present in the filter is not likely to increase and the threat of a fire propagating in a process cell or other ventilation area is significantly reduced. This threat can be further reduced through strict adherence to good housekeeping practices during any D&D activities. D&D for the facility will be addressed in an SAR for that activity. D&D is defined as an activity in and of itself. Decontamination of SSCs (prior to general facility D&D) and maintenance of facilities in shutdown status are adequately covered in existing SARs.

The period of time when the risk is considered to be marginal is limited by virtue of the planned usage for the facility. If the period of risk is considered in the evaluation, the probability for the DBF occurring during this limited time period reduces the risk to a conservative 1 or 2. (See section 9.) This level of risk over a longer period of threat is considered acceptable.

The other accident considered "marginal" involves the collapse of the Main Stack. This event is considered marginal because of the possible impact it would have within the ICPP. The consequences are evaluated in terms of a worse-case scenario where deaths occur and facility damage is caused. The marginal categorization is arrived at in a conservative analysis.

The stack is not designed to survive the currently described DBE. Collapse of the stack could result in serious injuries or deaths among personnel at the ICPP. Release of contamination from the event would be less than other scenarios for ICPP processes and would, in any event, be a secondary consideration to physical injuries and facility damage. There are no mitigating considerations for this event. The potential for personnel injury and secondary facility damage is an assumed residual risk that is no different from risks currently accepted.

The analysis indicates that in a variety of areas, off-gas, ventilation, and monitoring systems at the ICPP would be required to meet a more strict criteria were they to be built today using current criteria (i.e., DOE Order 6430.1A). When built, these more stringent criteria were not developed. The systems as designed and built (with the exception of the CPP-756 prefilter) have not departed from the original design of the components determined to be necessary for safety. With consideration given to the changing mission of the ICPP and the fact that the change reduces or eliminates challenges to equipment from the accidents considered, it is the conclusion of the analysis that continued operation of these systems does not result in consequences, with the exception of the prefilter vault, greater than those currently accepted for operation of the ICPP. The probability for the event may, however, be increased. In consideration of the changing mission of the ICPP significant equipment and facility upgrades are probably not urgently required.

5. FACILITY DESCRIPTION

This section discusses the design of the airborne waste management systems at the ICPP. Individual facilities at the ICPP are not discussed in detail here but are discussed in other sections of the PSD. Sufficient detail for an independent reviewer to become familiar with each building and its processes and operations is included in the PSD.

The principal design criteria and basis for design are discussed in section 4.

5.1 SUMMARY DESCRIPTION

5.1.1 Location and Plant Layout

The ICPP is located within the government-owned INEL. The ICPP complex is shown in figure 2.

Additional information on the location of the INEL, the location of the ICPP within the INEL, and the location of access highways and railroads is presented in ICPP SAR, Part I, Chapter 1.

5.1.2 Principal Features

The INEL is a government-owned, contractor-operated facility with limited public access. The INEL was government-owned prior to the inception of the Atomic Energy Commission and was used by the Department of Defense as a gunnery range and testing facility. With the transfer of the site to the Atomic Energy Commission, various government experimental programs dealing with nuclear energy, breeder reactor technology, power reactor technology, materials testing, space applications of nuclear power, nuclear fuel reprocessing, waste management, etc., have been conducted successfully at the INEL since the early 1950s.

5.1.2.1 Site Boundary. Since the INEL and all its facilities are government-owned, the site boundary for all INEL installations is the INEL perimeter as shown in figure 1.

5.1.2.2 Exclusion Area. The ICPP exclusion area boundary that relates to 10 CFR 100, definition[24] is the INEL site boundary (see figure 1). The nearest site boundary is 13.6 km (8.5 mi) to the south of ICPP. The DOE operates the INEL and controls access to all areas within its boundaries, except the public highways and the Experimental Breeder Reactor No. 1 (EBR-I) National Historic Monument. When necessary for public safety, DOE has authority to block or control public highways within the INEL.

5.1.2.3 Restricted Area. The area within the ICPP fence is the restricted area. Figure 2 shows the perimeter of the ICPP restricted access area.

5.1.2.4 Site Utility Supplies and Systems. The facilities are supplied with utilities such as potable water, firewater, plant air, and normal electrical power through extensions of the existing ICPP utility systems. ICPP utility systems are described in PSD Section 4.1.

The ICPP fire alarm system transmits information through the central processing unit at the Central Facilities Area (CFA) fire station. Alarm signals are also displayed at the CPP-669 guardhouse. Fire protection is not a feature of the airborne waste management system. Fire alarms and extinguishing agents are provided in plant areas that are served by the ventilation systems. In the event of a release or accident that requires personnel to evacuate the ICPP area, evacuation alarm systems are in place to provide notification.

An emergency radio network is maintained at the INEL under control of the DOE Idaho Operations Office (DOE-ID), Warning Communications Center (WCC). A transceiver is located at the Emergency Control Center (ECC) at the ICPP.

5.2 PLANT DESCRIPTION

5.2.1 Structural Specifications

The design criteria for the ICPP airborne effluent management systems are discussed in section 4.

5.2.2 Facility Descriptions

The specific structures and buildings principal to the airborne radioactive waste systems are described in other sections of this document. All structures and buildings within the ICPP are described in their specific PSD sections.

6. PROCESS SYSTEMS

The control of airborne effluent is primarily accomplished through the design of ventilation and process off-gas equipment and systems. This design is required to accomplish specific goals in the mitigation or prevention of airborne releases. There is a theoretical basis of operation dependent upon the design of the systems. This section discusses this objective in the design and how the systems are installed to meet that objective. The design criteria including DOE orders, other regulatory guides, and standards describe the objective or the theory utilized to achieve these safety goals. The following discussion provides general information regarding all ICPP systems. Specific descriptions are found in other sections of the PSD dealing with individual processes and facilities.

6.1 DESIGN THEORY FOR OPERATION

Management of airborne effluent at the ICPP can be characterized as a control program to limit the exposure of personnel, the environment, and the public from potentially harmful releases of hazardous or toxic materials. The principal design consideration in providing this control is through the isolation of these materials using multiple barriers against the release of these materials into occupied areas or the environment. Limited quantities of toxic or hazardous materials that are expected to be released during normal operating conditions are considered in the design of the systems. Equipment is installed to contain these releases or to reduce the quantities to levels that are both below regulatory limits and are, beyond that, ALARA. The following terms and definitions for confinement systems are provided in DOE Order 6430.1A:

> **Confinement Area.** An area having structures or systems from which releases of hazardous materials are controlled. The primary confinement systems are the process enclosures (gloveboxes, conveyors, transfer boxes, other spaces normally containing hazardous materials), which are surrounded by one or more secondary confinement areas (operating area compartments).[2]

Confinement System. The barrier and its associated systems (including ventilation) between areas containing hazardous materials and the environment or other areas in the facility that are normally expected to have levels of hazardous materials lower than allowable concentration limits.[2]

Section 1321-5 of DOE Order 6430.1A describes the design criteria for the confinement systems of reprocessing facilities. Three confinement systems (primary, secondary, and tertiary) are defined. The primary confinement system consists of process equipment (vessels, piping, etc., that actually contain the process solutions) and its associated off-gas system. The secondary confinement system consists of the process cell barriers and the ventilation systems associated with the cells. The process building and associated ventilation system compose the tertiary confinement system.

The basic objectives for confinement systems, as listed in DOE Order 6430.1A are the following:

1) Minimize the spread of radioactive and other hazardous materials within the unoccupied process areas.

2) Prevent, if possible, or else minimize the spread of radioactive and other hazardous materials to occupied areas.

3) Minimize the release of radioactive and other hazardous materials in facility effluent during normal operation and anticipated operational occurrences.

4) Limit the release of radioactive and other hazardous materials resulting from DBAs including severe natural phenomena and manmade events. Releases of hazardous materials postulated to occur as a result of DBAs shall be limited by designing facilities such that at least one confinement system remains fully functional following any credible DBA (i.e., unfiltered or unmitigated releases of hazardous levels of such materials shall not be allowed following such accidents). Facility design shall provide attenuation features for postulated accidents (up to and

including DBAs) that preclude off-site releases that would cause doses in excess of the DOE Order 5400 series limits for public exposure.

DBAs are defined in DOE Order 6430.1A as "postulated accidents, or natural forces, and resulting conditions for which the confinement structure, systems, components, and equipment must meet their functional goals."[2] A further DBA is defined in DOE Order 6430.1A as an "Operational DBA."[2] It is defined as, "Any design basis accident caused by an internal event. Direct causes are usually poor design or procedures, operator errors, equipment failures, or inadequate technical development (unknowns) that lead to the accident. The major accident categories are explosion, fire, nuclear criticality, leaks to the atmosphere, and leaks to the aquatic environment."[2] Within the lifetime of the facility there may also be additional accidents identified that were not originally considered in the design or became possible during use of the facility. These are called evaluation basis accidents. Many of the postulated accidents or unusual occurrences possible within the off-gas and ventilation systems are classified as operational or evaluation basis accidents.

There are no ESFs built into these systems. Some of the components are, however, safety class. System performance depends upon administrative controls. The safety analysis considers these accidents. Administrative controls requiring safe shutdown of the facilities are implemented to provide the margin of safety required to protect the public, personnel, and the environment.

Safety class items are defined in DOE Order 6430.1A as, "Systems, components, and structures, including portions of process systems, whose failure could adversely affect the environment or safety and health of the public. Determination of classification is based on analysis of the potential abnormal and accidental scenario consequences as presented in the SAR (as required by 5481.1B)."[2,25] They are those items necessary to ensure the capability to safely shut down operations, maintain the plant in a safe shutdown condition, and maintain the integrity of the final confinement barrier against the release of radioactive or other hazardous materials; to prevent or mitigate the consequences of accidents; or to monitor releases that could result in off-site exposures. When the DBA is an operational DBA, as determined by the SAR (one caused by poor design, procedures, etc.), upstream processes that are conducted in vessels and systems designed to a more severe event are curtailed. An evaluation based accident may cause the processes to be terminated and will, at least, cause a review of the process and the formulation of a basis for interim operation (BIO). Discontinued operations cannot continue when less adequate designs or other failures downstream cause the operational DBA to occur or until a BIO is prepared and approved. For example, most process systems are designed to withstand a DBA. If the systems required to monitor releases fail before the process system, processes must be discontinued until the monitoring capabilities are restored or other bases are developed to allow operation.

In addition to the requirements given in DOE orders, the criteria and design guidance contained in the ANSI Design Guides for Radioactive Material Handling Facilities and Equipment should be considered as current criteria in the design of confinement systems and areas. The document contains 12 design guides for the construction of confinement areas and their associated ventilation systems. This format was used by the ANS-11 subcommittee of the ANS due to the diverse and often unique requirements of many types of confinement systems. Rather than detailed standards, it is recognized that some systems require special equipment designed for a particular task. Examples of these would be the antimony and ruthenium adsorbers used at the ICPP. The ANSI guide recommends fire protection equipment for hot cell ventilation systems. The actual design of these systems is left to the designer and not to a fixed standard. The design guides supply a variety of acceptable methods to provide this protection. The designer has flexibility in providing the system as long as a system is included in the design. The need for the system is determined by the SAR.

The processing facilities of the ICPP are designed with a primary confinement system that includes the process vessels (e.g., fuel dissolution vessels, storage vessels, complexing and extraction vessels, denitration process vessels, and waste storage tanks, as well as others). Included as a part of these systems and as a part of the primary confinement are the associated off-gas systems, which are variously referred to as POG, VOG, sample off-gas (SOG) and DOG, as well as other systems that are provided for laboratories, caves, hoods, and other such pieces of equipment.

These confinement systems (process enclosures and off-gas systems) are contained within confinement areas, which may be process cells or laboratory rooms. Each of these areas has a ventilation system that is designed to control vacuum and provide a pressure gradient through the area. These areas and the associated ventilation system constitute the secondary confinement barrier. Ventilation systems are so designed that should a leak occur in the primary confinement system, the hazardous materials are contained within the process enclosures. Ventilation flow is directed so that it originates in areas where there is no potential for contamination. It is then directed through occupied areas and operating areas and, from there, into those confinement areas that contain the primary confinement systems. Both the primary and secondary confinements' effluent streams are cleaned or filtered prior to their release.

The theory of operation for process and ventilation confinement systems at the ICPP can be summarized in the following points:

1) POG, VOG, and DOG systems are composed of off-gas systems for vessels used for the makeup of contaminated process solutions, and the separation, collection, and concentration of product and waste materials. These processes are vented through separate POG, DOG, or VOG systems and are released after filtration to the environment. POG, DOG, and VOG systems are primary confinement systems. The confinement areas in which these vessel systems are enclosed draw a regulated air supply from the ventilation system or the plant air system of the facility.

2) SOG systems, laboratory hoods, decontamination sink hoods, and gloveboxes are primary confinement systems (enclosures) within

which radioactive or otherwise hazardous materials can be safely contained. These enclosures draw a regulated air supply from the ventilation system. The flows from these systems can then be directed to their own filtration and cleanup systems or back into the ventilation system (after filtration) for final filtering prior to being released from the facility.

3) A ventilation system originating in an area where there is no potential for contamination from normal processing activities is provided for the confinement area(s). This stream is directed through office areas and other occupied areas (in the tertiary confinement system) and from there into the confinement area(s) of the secondary confinement system containing the primary confinement system(s). Ventilation air that passes through the primary confinement area(s) is filtered prior to release from the facility even though it may not be contaminated. Ventilation systems serving process cells, laboratory areas, and waste storage vaults, etc., are an element of the secondary confinement system.

6.2 DESCRIPTION

The following ARPs of radioactive byproducts to the atmosphere are of the most concern. These are points for which specialized sampling and monitoring are required due to normal operational effluent. Only the monitors at the Main Stack and the NWCF stack are considered safety class based upon DOE Order 6430.1A. The release points are 1) the Main Stack, CPP-708; 2) the stack at FAST, CPP-666; 3) the stack at the NWCF, CPP-659; and 4) the stack at the RAL, CPP-684. Of these four release points, the Main Stack and the FAST stack have, in the past, released 99.99% of ICPP measurable radioactive atmospheric releases. With the change in the ICPP mission, the FAST stack will release much less than before, the mission of this facility having changed from fuel processing and storage to fuel storage. The system currently installed for FAST effluent control and monitoring is designed and installed as safety class equipment. This level is no longer required by the current mission. In the future virtually all airborne radioactive effluent originating from normal operations will be exhausted through the Main Stack.

In addition to these principal release points, there are other confinement areas that may generate lesser quantities of radioactive materials during normal operation. These include the laboratories in CPP-637 and CPP-627, which exhaust their hoods through filtration systems from vents on the roofs of those buildings. Other laboratories located in CPP-602 and the CPP-630 mass spectrometry lab release their effluent from the ventilation and confinement flows after filtration (via the fan loft for CPP-602) from the roofs of CPP-602 and CPP-630. Ventilation air from the Irradiated Fuel Storage Facility is filtered and released from the roof of CPP-603.

Other atmospheric release points exist that may exhaust industrial waste gases such as NO_x, SO_2, and ash. This section of the PSD discusses only those systems for which filtration and monitoring (sampling) are required to control or mitigate radioactive releases.

Each of the four major ARPs identified above (CPP-708, CPP-666, CPP-659, and CPP-684) are provided with monitoring equipment to supply a sample that can be quantified and a real-time monitor to provide immediate notification of an unacceptable release. The monitoring station for the Main Stack is discussed in section 6.4. The monitoring station for the FAST/FDP process is discussed in PSD Section 5.6, the RAL is discussed in PSD Section 4.10, and the NWCF is discussed in PSD Section 8.2. Following is a discussion of the process and ventilation flows that are released from the Main Stack. Descriptions for FAST, the NWCF, the RAL, and all other release points and processes are found in their respective sections of the PSD. Processes that vent to the APS and the Main Stack are described as they relate to operation of the APS systems but the complete systems are described in their respective PSD sections.

Ventilation and process off-gas systems are described in the following sections as they are configured for "normal" operation. Due to designs that, in most cases, provide a "defense-in-depth" against filter failures, individual components of these systems are allowed to be removed from service for filter changeouts and other necessary maintenance operations. Bypasses are provided for these operations. Due to multiple stages of filtration provided by these systems, these bypasses do not cause a significant increase in total emissions from an ARP. It would require multiple failures in conjunction with failures in the primary confinement to cause an unacceptable radioactive release.

Bypassing individual pieces of equipment for maintenance purposes is considered to be an acceptable risk that is required to ensure the continued acceptable performance of the entire system. Scheduling of outages ensures that these periods of downtime are kept to a minimum and attempts are made to schedule these activities with planned shutdown of processes when possible.

Process configuration changes requiring lengthy periods of downtime are evaluated against the safety envelope when required. These evaluations follow the format required in DOE Order 5480.21[26] concerning USQs.

6.2.1 The Main Stack and Atmospheric Protection System

The APS and the ICPP Main Stack (CPP-708) comprise a final filtration and ARP for several processes and ventilation systems. The APS has two sides (refer to figure 3). One side (ventilation APS) primarily filters ventilation air. The other side (POG APS) is designed to filter the more contaminated, moisture laden, process effluent. This side is also designed to handle effluent containing high amounts of NO_x present in some process gases. The ventilation side handles the ventilation air including the filtered E-DOG. E-DOG is routed to the ventilation system to allow rapid dilution of effluent which, under unusual conditions, could be explosive. E-DOG has been out of service, is awaiting D&D, and is valved out upstream of the APS. The process side handles the DOG, VOG, and calciner POG. These systems are collectively referred to as the APS.

6.2.1.1 The Main Stack (CPP-708). The ICPP Main Stack is a 250-ft-tall concrete structure lined with stainless steel. The inside diameter of the stack is a uniform 8 ft tapering to 6.5 ft at the very top. The taper increases the exit velocity of the stack effluent. The total exhaust flow rate is a nominal 110,000 scfm (135,000 cfm).

The Main Stack is the final release point for ventilation air and POG from a variety of plant areas at the ICPP. Four connections are provided 11 ft up from the base plate. One connection is for the POG from the LET&D Facility (CPP-1618). A second connection is provided to exhaust process gases from the CPP-637 High and Low Bay laboratories (this effluent can also exhaust from the roof of CPP-637 after HEPA filtration, or to the CPP-601 VOG system). A third connection exhausts process gas from the NO_x Pilot Plant, and the fourth connection provides a jet system for liquids that might collect in the sump at the bottom of the stack liner. The effluent from the LET&D facility and the NO_x pilot plant are filtered at those facilities prior to their release to the stack. There are no penetrations below the 11-ft level.

Processes and effluent streams that have contributed to the total effluent from the stack include 1) chemical dissolution of nuclear fuels, 2) separation of uranium from dissolved solutions by organic extraction, 3) conversion of recovered uranium from a liquid to a solid product, 4) calcination of liquid wastes generated during the dissolution and recovery processes, 5) gases generated from the storage of high-level liquid wastes, and 6) recovery of noble gases produced during dissolution of fuel [recovery of gases in the Rare Gas Plant (RGP) reduces released activity]. The LET&D Facility releases its airborne effluent to the Main Stack after filtration. Releases from the LET&D are a minor contributor to the stack release spectra.

Ventilation exhaust is the major contributor in terms of volume to the Main Stack. The total flow rate for ventilation air is nominally

105,000 scfm. The flow rate for process gases is nominally 5,000 scfm. Whereas ventilation air is the greater volume of air released, it is a minor contributor in terms of radioactive or hazardous releases. The confinement systems within the process maintain the ventilation air in a comparatively clean condition.

The 16-ft elevation in the stack contains the penetration for ventilation air from CPP-601, CPP-604, CPP-633, CPP-640, CPP-649, CPP-1618, the Tank Farm relief valves, and E-DOG. A penetration at the 27-ft level exhausts POGs from CPP-601, CPP-604, the Tank Farm, NWCF, and the WCF.

In 1979 the stack was upgraded (a concrete sheath was installed). In 1984, a second concrete sheath, a broader concrete base, and a stainless steel liner were installed. An evaluation completed by Ralph Parsons Engineers and reviewed by EG&G, Inc., indicated that the stack would survive an operational basis earthquake (OBE) with a horizontal ground acceleration of 0.12 g or a wind loading of 95 mph. The Main Stack is qualified for a seismic event with a probability of E-03/y. It could fail at some point beyond this magnitude of seismic event.

6.2.1.2 Process Off-Gas Atmospheric Protection System. Separation of the process flow from the ventilation flow allows the special conditions for POG to be considered in the design. The POG side of the APS treats three flows. One flow is the combination of flows from the CPM DOG and process effluent from the RGP. This effluent path is passed through a mist eliminator (WN-126) and a superheater (WN-304), which provide protection from condensates for the downstream filter (F-WN-167). Vacuum on the system is maintained by blowers WN-250 or WN-251. A steam jet (WN-550) can be used to provide vacuum as a backup for the blowers.

The second flow is a combination of VOG from the Tank Farm, CPP-604, the RGP, and (after pretreatment in the CPP-601 mist eliminator VT-300) the VOG from CPP-601 process vessels. This effluent passes through mist eliminator WL-127 and superheater WL-305. From WL-305 the stream is filtered by the VOG filter, F-WL-121. The mist eliminators and superheater provide protection from water damage to the downstream filters. Vacuum on this system is maintained by blower WL-209 or a backup steam jet WL-509. The third flow originates at the NWCF and the WCF and combines before entering the POG APS.

The three flows combine into one flow downstream from blower WL-209. This combined stream is treated through a condenser (OGF-104), a mist eliminator (OGF-132), and a superheater (OGF-106). Prior to 1995 the effluent then passed through a bank of HEPA filters (OGF-131), another superheater (OGF-308), and a final bank of three parallel HEPA filters (OGF-100, -101, and -102). This configuration caused operational problems and was subject to failures from moisture and excessive particulate buildup from gasketing materials vaporizing in the electric superheater. Filter OGF-131 may have been the source of the sealer. In addition, the three final filters could not be individually isolated for changeout and, due to the potential for NO_x releases into the work areas, the calciner processing had to be terminated to replace filters OGF-100, -101, and -102.

The system was redesigned to eliminate the moisture and differential pressure problems. Improved detection of filter failures was provided by providing constant monitoring of ΔP through the process control system. Filter OGF-131, heater OGF-308, and filters OGF-100, -101, and -102 were removed. These components were replaced by a bank of five parallel filters, F-OGF-133, -134, -135, -136, and -137. Each of these filters can be isolated for changeout without termination of the calciner operations. Not all filters must be on-line at any time. Filters can be isolated individually or in groups to provide back-up to the system or to tune ΔP pressure differentials in response to changing process conditions.

Removal of OGF-131 without other modifications would result in a reduction of one testable stage of HEPA filtration on a POG system. The affected system would have been the VOG (refer to figure 3.) In 1994 in-place aerosol test ports were added to the VOG filter (F-WL-121). This change provides two testable stages of HEPA filtration on all APS-POG airborne effluent routes. The initial stage for NWCF is provided at the NWCF facility (CPP-649). The new configuration is, after evaluation against the old authorization basis, to provide equal or improved service and safety than the system replaced. Vacuum for the entire POG APS is provided either by blower OGF-213 or -214.

Some POG streams at the ICPP can contain relatively large amounts of moisture. Condensation of this moisture laden effluent can occur prior to final filtration in the APS. As described in the Energy Research and Development Administration (ERDA) Nuclear Air Cleaning Handbook,[27] condensate droplets greater than 9 microns in diameter can significantly degrade HEPA filter media and cause filter failure. As described above, filters OGF-100, -101, and -102 have failed due to moisture damage in operational history.[28] These failures were attributed to moisture generated in the operation of the NWCF, the WCF, or the VOG steam jet. The scheduled upgrade described above reduces heat loss in the system and eliminates the need for the electric superheater. Any moisture generated by operation of steam jets can be controlled, when required, by vessels OGF-104 and OGF-132, and super-heater OGF-106. Operation of vessel OGF-104 is not required during all operations. Liquid waste is minimized by operating the condenser only during those periods, as determined by management, when moisture entrainment in the effluent might cause filtration problems in the final filter bank.

The condenser (OGF-104), when operating, removes a fraction of the vapor. The condenser was installed to remove condensate resulting from the operation of steam jets. Cooling water is not run through the condenser, except when the jets are used to provide vacuum on the system or other conditions during which large diameter liquid particles are present in the effluent.

The mist eliminator (OGF-132) is designed with an efficiency of 99.9% for aerosols of 9 microns or greater.[29] The collected water flows from the bottom of the mist eliminator to the PEW (vessel WL-137 and from there to WL-132/-133). The resulting PEW condensate is treated through the LET&D Facility. Superheating of the off-gas (20°C above the inlet temperature) through two superheaters (WL-305 and OGF-106) protects against further large aerosol formation and provides protection for the final filter banks. If the VOG filter fails, due to high moisture loading, the second superheater will, when operating, help preserve the final bank. The design of two filter banks, each protected by superheaters, provides added assurance that final filtration will not be compromised due to large aerosol formation. The final stream is exhausted through blowers OGF-213 and -214 to the atmosphere via the Main Stack.

At the NWCF, the POG is treated and passes through one of three blowers (NCC-243-1 and -2, or NCC-242). These blowers provide the vacuum for the VOG and POG of the calciner process and maintain the integrity of the primary barrier (for a complete description of the NWCF off-gas and ventilation systems, refer to PSD Section 8.2). Certain maintenance activities occasionally require that these blowers be removed from service. The bypass route for these activities involves venting the POG filter effluent to the valve cubicle cell at the NWCF. Other maintenance work on the APS systems may occasionally require the same diversion route.

Using the valve cubicle cell diversion route compromises the primary confinement of the POG by venting these gases through the secondary confinement and out the NWCF ventilation stack rather than the Main Stack via the POG APS. During these evolutions there is no negative pressure differential between the process vessels (primary confinement) and the process cells and sample stations (secondary confinement). A process upset or pressurization of the primary confinement would result in a release of radioactivity to the secondary confinement. The effluent has already been initially filtered through the POG HEPA filters at the NWCF. The effluent receives an additional filtration during the diversion through the NWCF ventilation filters prior to release from the NWCF stack. The operation is allowed only during periods of calciner shutdown. Therefore, excessive moisture, NO_x, and radioactivity in the off-gas stream are sufficiently reduced for normal downtime operation.

The venting of the POG to the valve cubicle cell is allowed by procedure provided the following conditions are met:

1) The HVAC stack monitor is operable (R-NC-1771-1, -2).

2) No process activities are allowed.

3) All vessel sparges are minimized.

4) No process transfers are allowed.

5) Cell entries are administratively controlled.

All of the POG filters (inclusive of DOG, VOG, and POG filters) can be isolated to allow for the replacement of filters, as required. Bypassing any filter bank is done only for filter or housing maintenance. The final filters, OGF-133 through -137, can be individually isolated without compromising the final confinement barrier. Normal operation of the POG APS requires two stages of testable filters to be in service and operable at all times except for filter changeout and other maintenance activities that may be required.

6.2.1.3 Ventilation Atmospheric Protection System. Ventilation air from CPP-601, CPP-640, CPP-604, CPP-633, CPP-649, CPP-1618, and the Tank Farm pressure relief valves come together in a common duct and flow to the CPP-756 prefilter. After the prefilter, the airflow goes to CPP-649 and to the APS, where it passes through a bank of 104 parallel HEPA filters arranged in 26 banks. Just before the blowers (WL-210, WL-211, and WL-212), the E-DOG enters the stream. E-cell is inactive, but is in a standby mode. The E-DOG system is valved out at the APS.

The E-DOG first passes through a mist eliminator (VT-102) in CPP-601. From VT-102, the stream flows through mist eliminator WL-128 in CPP-604. From WL-128, the stream passes through a superheater (WL-306), a HEPA filter (F-WL-122), a prefilter (F-WL-154), another HEPA filter (F-WL-155), and enters the ventilation stream between CPP-649 and the ventilation blowers (WL-210, -211, and -212).

As mentioned above, E-DOG is currently valved out at WL-128. This is done by closing and securing valves DGV-WLU-4, DGV-WLU-9, and

DGV-WLU-11. Surveillance requirements and Group I instrument requirements are not needed for this system during the valveout isolation. When the system is brought on-line for D&D purposes, all instruments will be calibrated as specified in a D&D SAR or through USQ evaluations. All operability requirements are addressed in the SAR for D&D or as a result of USQ evaluations comparing D&D proposals to operational safety requirements.

Vessel process and DOG (except E-DOG, described above) from CPP-601, CPP-604, the Tank Farm, the NWCF, and the WCF, come together in CPP-649. APS process and VOG system prefilters and HEPA systems in CPP-649 remove particulate material prior to exhausting these gases at the 27-ft level in the stack.

The ventilation system (composed of ventilation air from CPP-649, CPP-604, CPP-633, CPP-601, and the pressure relief valves from the Tank Farm) is routed through a deep-bed fiberglass filter (CPP-756, an underground concrete vault) to the ventilation exhaust filter system in CPP-649. The ventilation air ducts from the various ventilation systems and the Tank Farm pressure relief valves join before entering the prefilter plenum. The distribution plenum extends the full length of the vault and distributes air into each of four filter bays. The prefilter has an area of 3000 ft^2 and has a design flow rate of 150,000 cfm.[30] The prefilter is designed for gas upflow at 50 ft/min through five layers of varying density, separately supported, packed fiberglass. The five individual layers are separated and supported by stainless steel wire screens. The screens are mounted on epoxy painted carbon steel frames and wired to support pipes spaced at 3-ft intervals. The prefilter frame is attached to the unistrut embedded in the vault walls. Voids in the unistrut are caulked and sealed to prevent bypassing of the filter media. The prefilter is located upstream in series with the APS HEPA filters. Refer to figures 5, 6, and 7 for the prefilter, ventilation APS filter building, and the CPP-604 and CPP-605 building configurations.

The CPP-756 prefilter was designed with an expected life of 20 years (from 1975). However, the estimated dust loading, which has accumulated

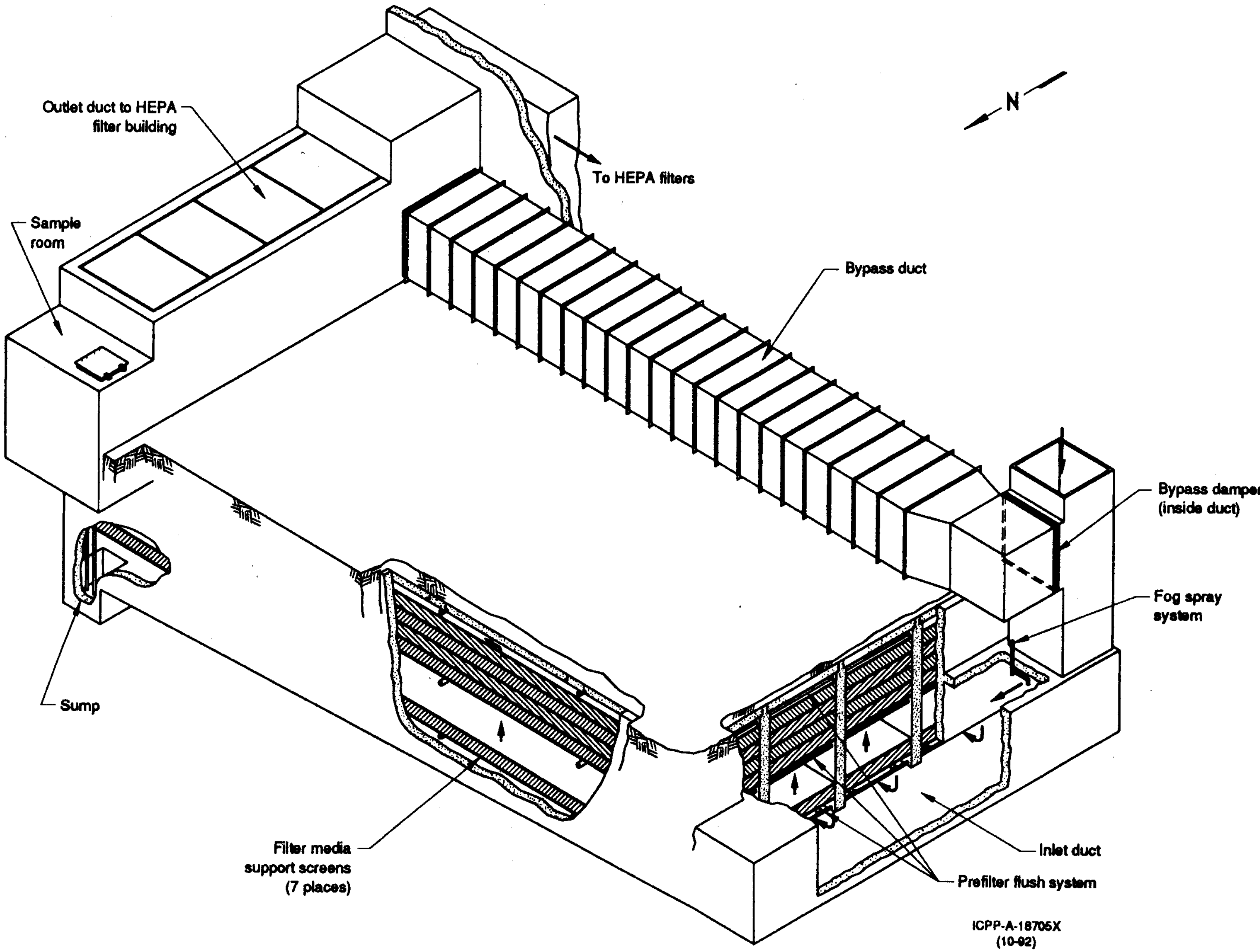


Figure 5. Isometric View of Ventilation Air Prefilter Vault

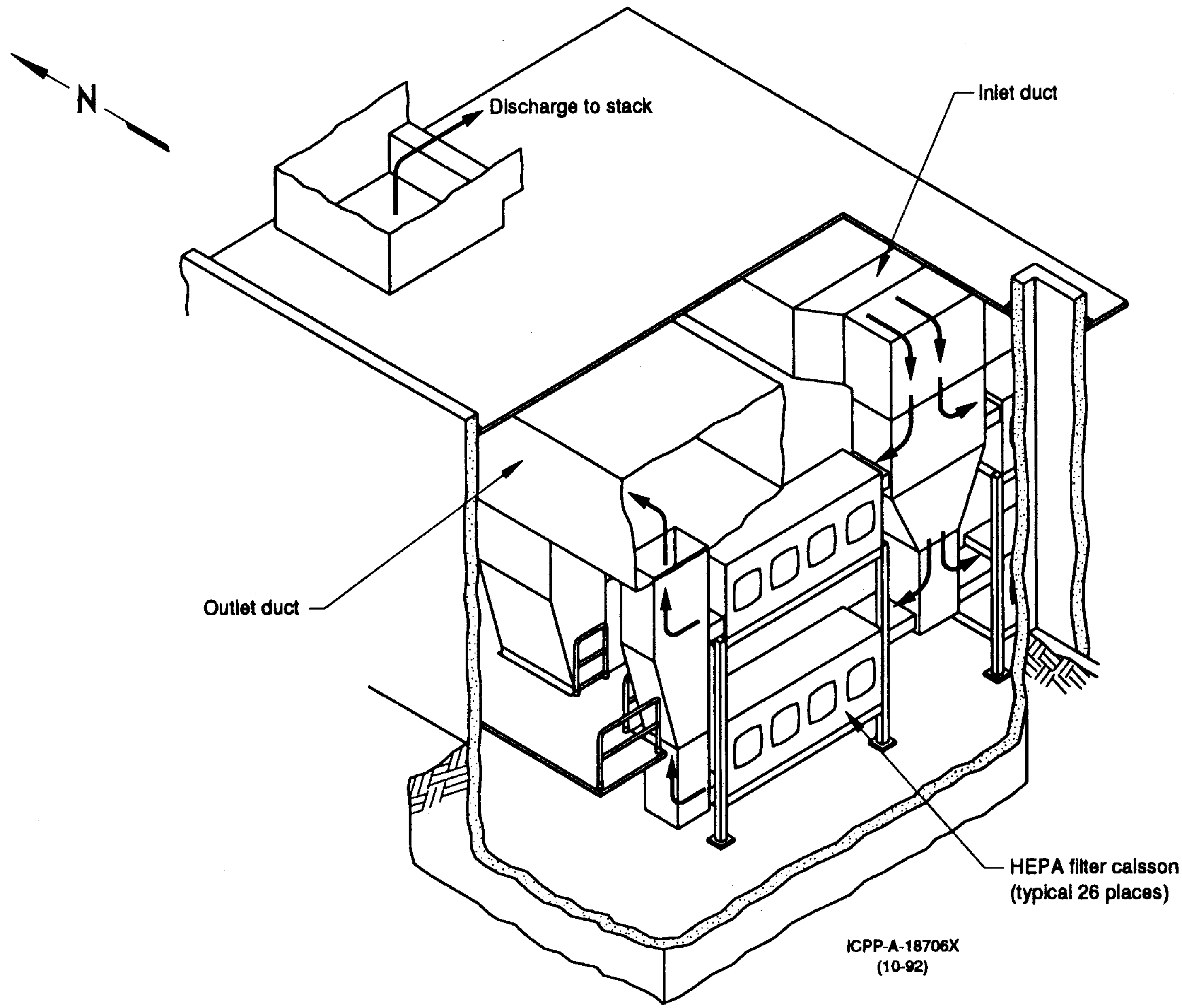


Figure 6. Isometric View of a Section of the Ventilation Air HEPA Building

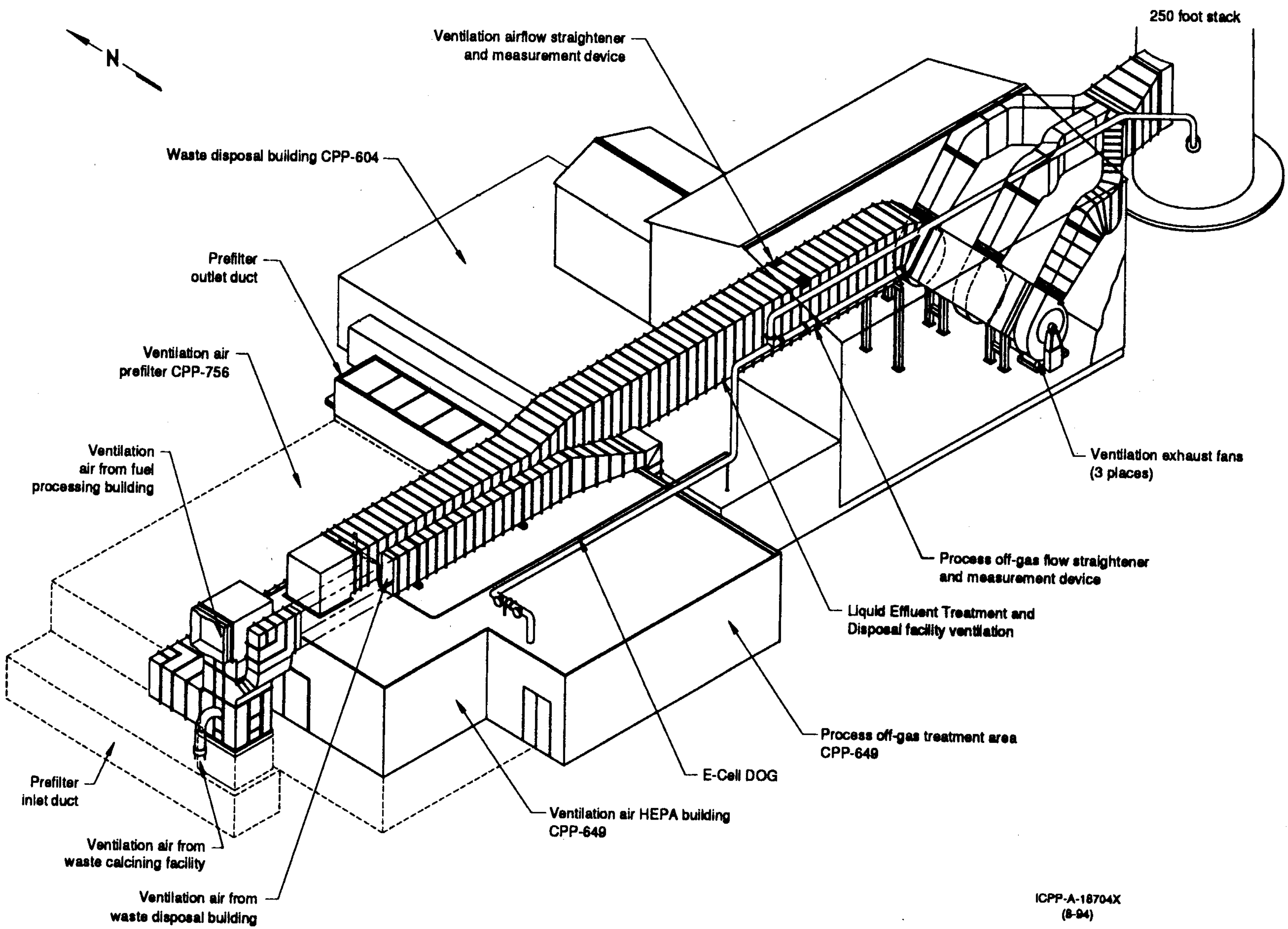


Figure 7. Isometric View of the Atmospheric Protection System

since installation, indicates the filter should last about 75 years without backflushing or replacement. If some unexpected particulate loading caused a substantial increase in pressure differential, water flushing could be required sooner. Flushing was performed after 18 months of operation with no apparent adverse effect on the prefilter media. Water flushing can no longer be performed due to reasons explained below.

The prefilter is located in an underground reinforced concrete vault that is 40 x 90 x 14 ft high. The vault includes a system for backwashing the filter media. This backflushing system has been disconnected but could still be used, if required. A bypass duct is provided around the prefilter for use during washing of the filter media. The bypass baffle is operated by a chain fall to open and close the damper. The damper and chain fall can no longer be used to bypass the filter. The prefilter was equipped with a fog spray and heat-activated sensors installed to protect it from upstream fire. The system could not be tested and has been removed from service.

The floor of the vault is sloped to the north; four troughs drain condensate or flush water to the north edge of the vault. From there, another trough carries the water to a 500-gal collection sump located in the northeast corner of the vault. The sump is equipped with a high-level alarm, a transfer jet, and a sampler.

The south wall of the vault has six viewing ports for inspection of the vault and filters. No lights are provided in the vault; portable lighting is used when needed.

The roof of the vault is belowgrade and is covered with dirt for radiation shielding. The roof is sloped for runoff. When built, the vault was of leakproof construction. This cannot be verified today; however, the absence of moisture collecting in the sump indicates that there are no major leaks to the vault. There are four radiation wells, which allow radiation readings to be taken at differing levels in the vault interior. From this data, a radiation profile can be obtained and total radioactive loading can be calculated.

Ventilation air from the prefilter is discharged through a concrete duct to the HEPA filters located in building CPP-649 adjacent to the prefilter vault. The two-story building contains 26 caissons, each containing four filters. Each caisson of four filters is individually testable as one unit, using an approved aerosol smoke test (refer to figure 8). The caissons are arranged in a parallel configuration in relation to ventilation flow.

Each HEPA filter is a 24 x 24 x 11 1/2-in. unit rated at 1000 scfm with an initial pressure drop of one in. of water. Each of the 26 caissons is individually dampered to allow it to be isolated from the remainder during filter changeout.

From the HEPA filters, the ventilation air normally flows through two of three ventilation fans (WL-210, -211, and -212; one fan is required) and is exhausted to the stack at the 16-ft level (from the base plate). The ventilation fans are direct-drive, installed in a parallel configuration. During normal operation, two of the three fans are operated on commercial power. If an operating fan fails, the third fan can be manually started on commercial power. Automatic switching of an operating fan to standby power can be selected during commercial power outages. Each fan is provided with a damper that will close automatically to prevent recirculation if the fan stops. In the event of total fan failure, a fan control bypass switch allows for instrument air (with nitrogen backup) to open all dampers and allow for natural draft up the stack. This provides minimal ventilation.

6.2.2 CPP-601, CPP-602, CPP-627, CPP-630

CPP-601, Fuel Processing Building, has four major systems for off-gas handling. Most of the processes in these areas have been discontinued and are awaiting D&D. The ventilation and off-gas systems are still intact, though some are valved out. These systems can be used in future D&D work, should they be required. The ventilation system is still intact. All ventilation systems designed for operating processes are maintained in an operational mode. This ensures the integrity of the secondary confinement. Several other systems feed into the ventilation

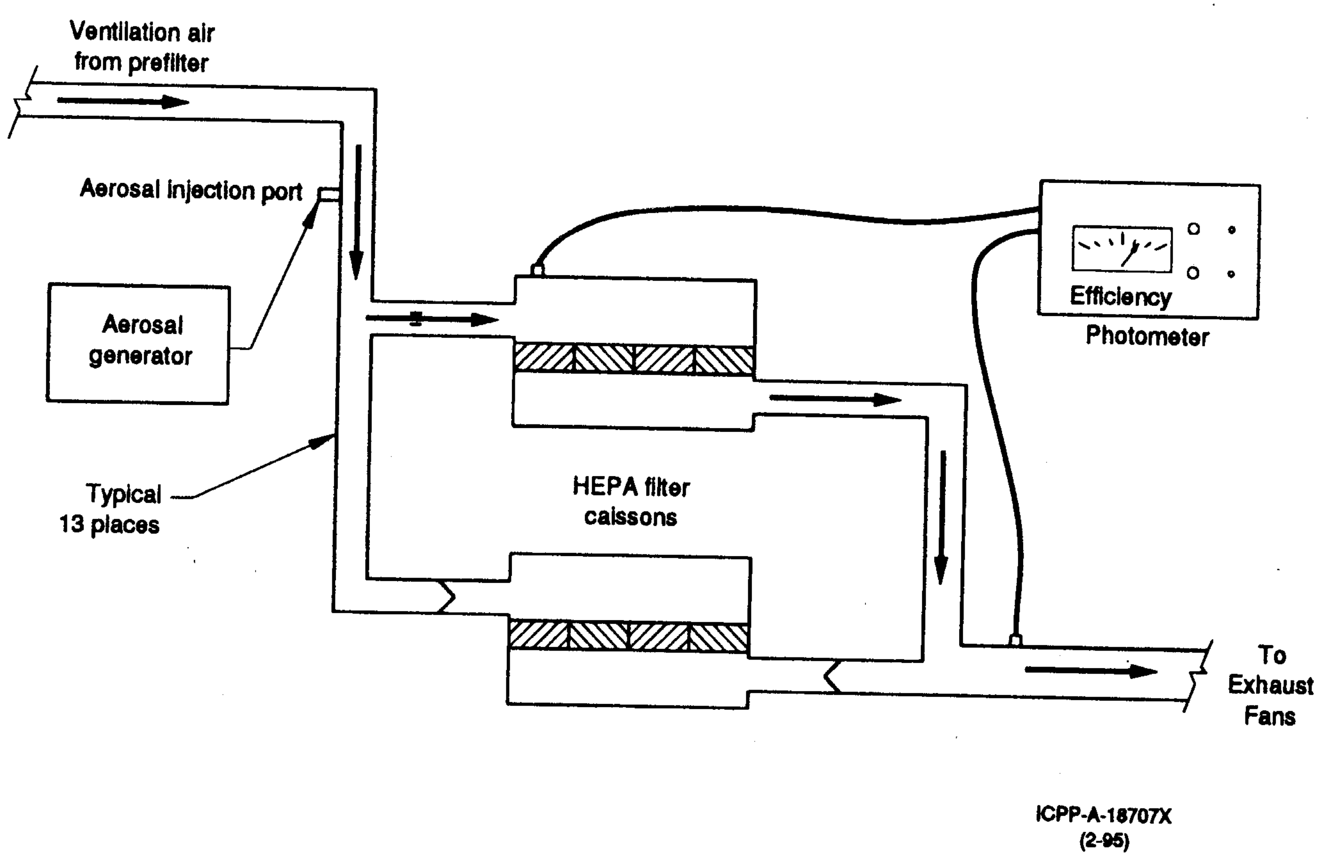


Figure 8. Schematic Diagram of In-Place Aerosol Test System

system. Among these are the SOG system, which routes sample station gases into the ventilation system via an SOG blower; the alpha cave in the basement of CPP-602, Laboratory & Office Building; and the hood and gloveboxes in X-cell, which, after filtration, vent to the east vent tunnel. Ventilation air from the denitrator area exhausts to the fan loft, is filtered, and is released from the CPP-602 roof. The ventilation and confinement flows from the mass spectrometry laboratory in CPP-630 exhaust to a HEPA-filtration system and are released from the roof.

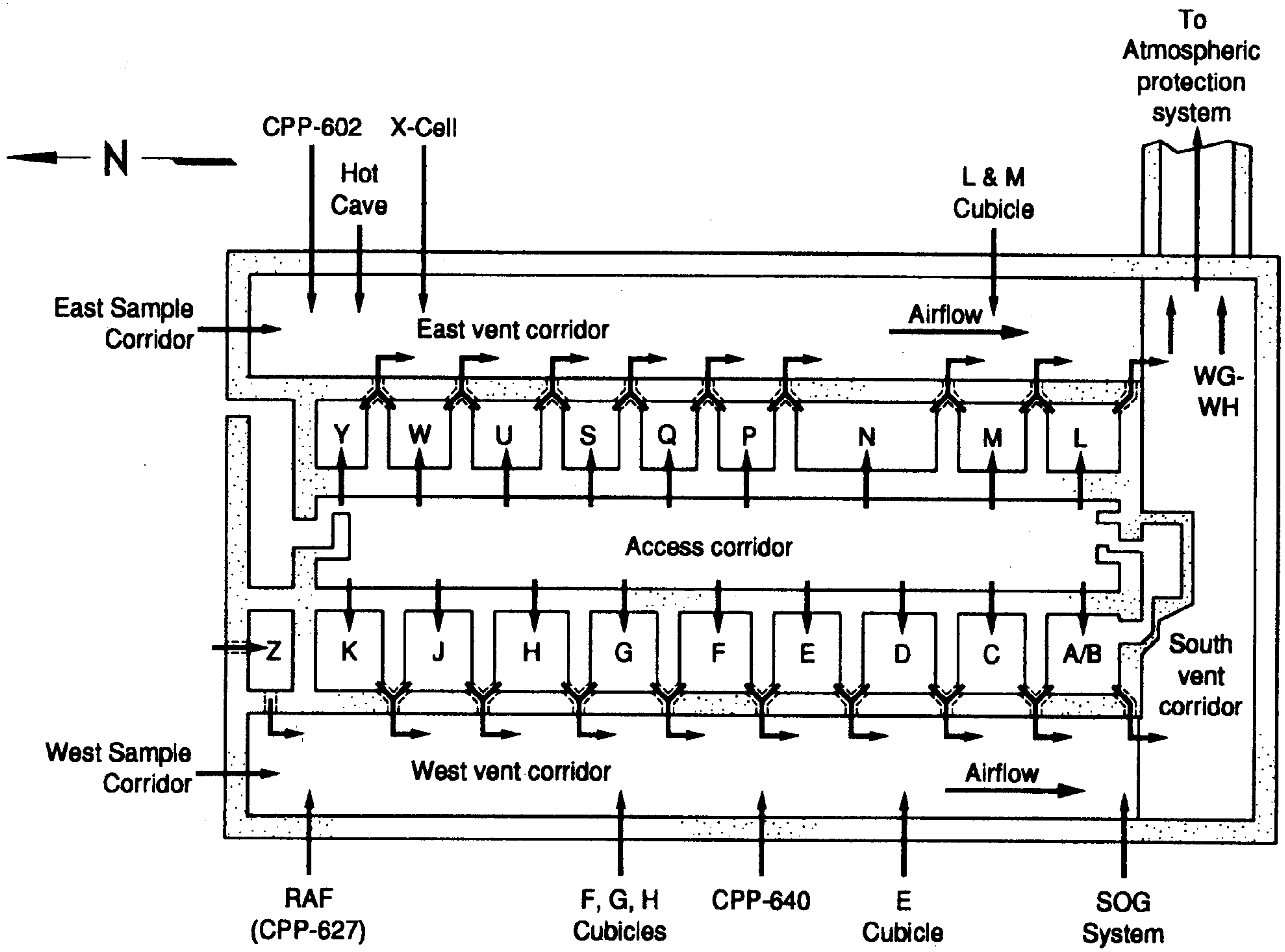
Flow diagrams for the CPP-601 cell ventilation flow, VOG, and a representative DOG flow (E-DOG) are included as figures 9, 10, and 11.

6.2.2.1 Ventilation System. The Fuel Process Building, CPP-601, is supplied with ventilation air by two variable speed forced draft fans from CPP-606 via CPP-602 (see PSD Section 4.1). Ventilation air is withdrawn by exhaust blowers WL-210, WL-211, and WL-212. These exhaust blowers, coupled with the supply fans and various blowers and dampers, create the required pressure differentials in the building.

Ventilation air for individual cells is drawn from the corridors and occupied areas of CPP-601. Vacuum to each cell is adjusted by manually adjusting dampers located in the vent tunnels. The dampers normally restrict airflow to maintain the cells at a vacuum, which results in a nominal flow varying from 500 to 1500 cfm. The pressure in each cell is measured by a pressure differential indicator (PDI) located outside the cell.

Airflow is through the dampers, into either the east or west vent corridor, and then into the south vent corridor. From the south ventilation corridor, air is exhausted from CPP-601 to the APS via the main exhaust duct.

The main exhaust duct from CPP-601 consists of 3/16-in.-thick carbon steel with the inside surface painted with acid resistant paint. The duct is 7 ft 6 1/2-in. square enlarging to 10 ft 9 1/2-in. by 7 ft 6 1/2-in. before entering the APS. The duct is covered by



Note: This sketch is a composite showing how air flows through access corridor louvres below vent corridor elevation.

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Figure 9. Processing CPP-601, Fuel Building Cell Off-Gas Flow

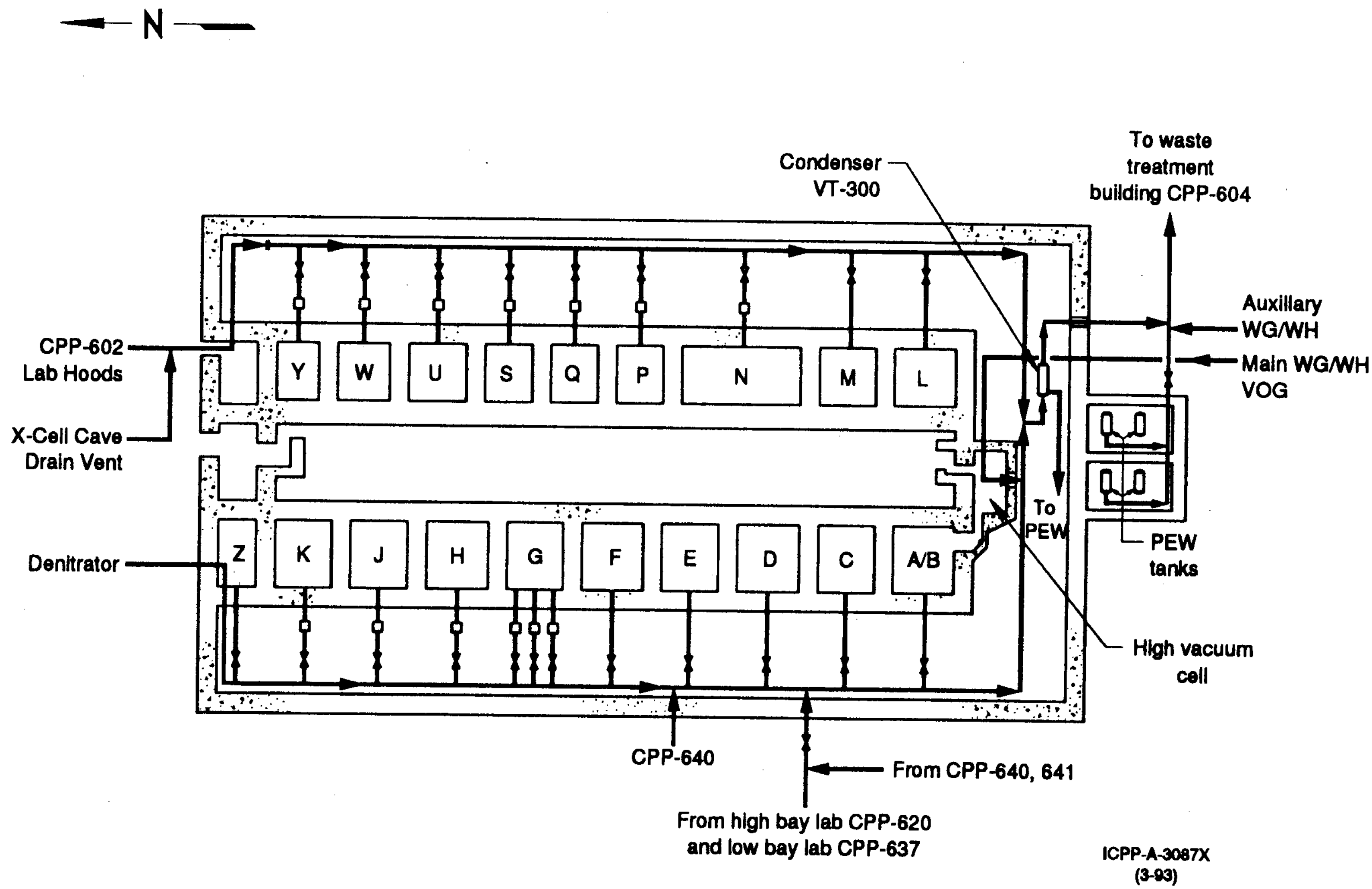

Figure 10. CPP-601, Fuel Processing Building Vessel Off-Gas Schematic

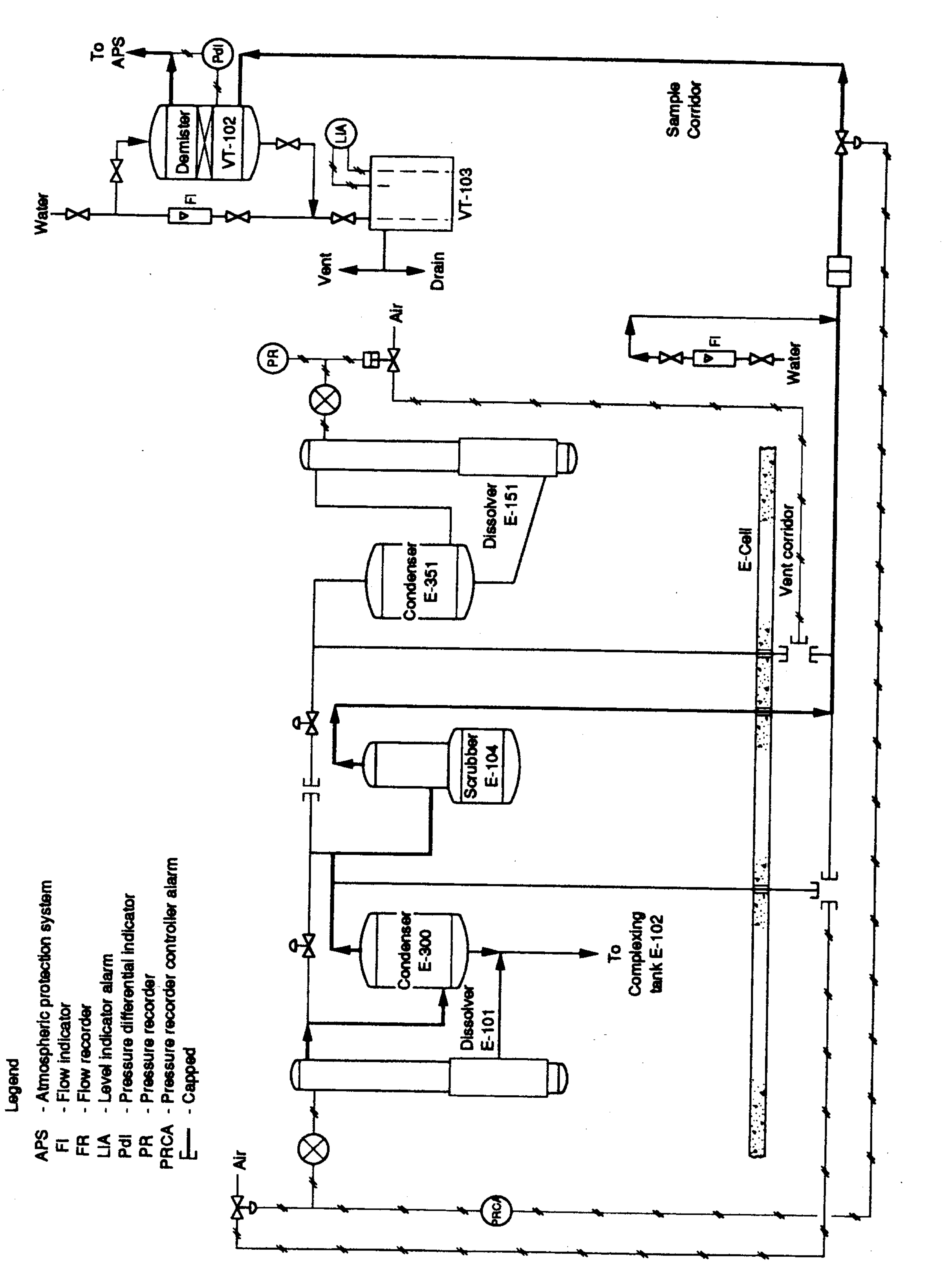

Figure 11. E-Cell Dissolver Off-Gas System

1-1/2-in.-thick fiberglass insulating boards, a layer of vinyl, and a 1/8-in.-thick layer of vapor seal. Between CPP-601 and the CPP-756, the duct is supported approximately 18 ft off the ground by 8-in. I-beam columns.

6.2.2.2 Vessel Off-Gas. The VOG system is a low volume system designed to vent the gases from process and storage vessels containing radioactive materials. Vessels vent to VOG headers outside of the process cells. Gases from the VOG system are directed through a condenser and a mist eliminator, then through filters for removal of particulate contamination.

Noxious gases from the denitration system (described in PSD Section 7.3) are also present in the VOG. During denitration, nitrogen oxides are produced as the uranyl nitrate product is decomposed to granular UO_3.

The VOG system is normally operated continuously with the motive force supplied by blower WL-209; a rarely used steam jet air ejector WL-509 is available as a backup. An 8-in.-diameter VOG header for CPP-601, CPP-602, CPP-620, CPP-627, CPP-637, CPP-640, and CPP-641 is routed from CPP-601 to the VOG filter system in CPP-604. Also connected to the VOG filter system are lines from vessels in CPP-604 and the Tank Farm liquid waste storage tanks. DOG can also be valved into the VOG system at CPP-601.

The main contributors to the VOG system are the vessels within the process cells in building CPP-601. Vent gases from the vessels in each cell flow from the vessel out of the cells to a 6-in. header in the ventilation corridors. Flame arresters were installed between the cell VOG line and the VOG header in cells that normally contain organic liquids. There was no provision in the design to allow them to be tested or verified. Due to their age and the environment in which they function, no credit is taken for their ability to provide fire protection. Cells E, F, G, and H have a condenser in the VOG line inside each cell. Other equipment (e.g., evaporators) is connected to condensers in the cell off-gas lines leading to the VOG headers.

6.2.2.3 Dissolver Off-Gas. All the dissolver processes at the ICPP are discontinued. The DOG systems remain intact, as described below, in the event they are required for future activities.

The gases and aerosols generated during fuel dissolution are the major contributors of radioactive waste that, prior to the mission change, was processed by the off-gas systems. As the irradiated fuels were dissolved, radioactive particulate and gaseous fission products were released. The particulate materials were entrained in the liquid aerosols and carried to the DOG systems along with the gaseous waste. Vapors and particulate contaminants were removed by condensation and filtration, respectively. Liquids were removed by mist eliminators. These off-gas systems are still used to provide and maintain the vacuum on the primary confinement vessels and lines.

Most of the gaseous fission products are allowed to decay before processing the fuel. However, since Kr-85 and tritium have radioactive half-lives of 10.7 and 12.3 years, respectively, they were still present in the fuel at the time of processing. With the change in mission, releases of these nuclides will decrease.

The DOG systems (E-DOG, CPM DOG, and FAST DOG) are designed to vent the gases that are evolved in the process dissolvers. The DOG systems are described in the following paragraphs.

6.2.2.4 E-Cell Dissolver Off-Gas. E-cell has been used for the dissolution of zirconium-clad fuels in hydrofluoric acid. The dissolver (E-101) has not been totally isolated. It has been valved out at CPP-604. Future activities may require the DOG system to be functional. Additional safety analysis will be required for any future activities.

During the normal operation of E-cell, off-gas from the dissolver passed through a condenser (E-300), a scrubber (E-104), and into a 2-in. header located in the CPP-601 west vent tunnel. The off-gas header leads to a mist eliminator (VT-102) in the south vent tunnel. From there, the off-gas went to the E-DOG/APS system in the off-gas blower room at CPP-604. At CPP-604 the gas passed through a mist eliminator (WL-128), superheater (WL-306), and HEPA filter (WL-122). From WL-122, E-DOG was directed to the APS where it passed through a prefilter (WL-154) and HEPA filter (WL-155). After this treatment, the gas was released through the ventilation blowers (WL-210, -211, -212) to the stack.

The E-DOG header vacuum was maintained by a steam jet (WN-552) and a pressure control valve. The header vacuum was normally maintained at 40 to 48 in. of water, and the dissolver vacuum was maintained at 5 to 10 in. of water. The jet exhausts the E-DOG into the ventilation exhaust duct between the ventilation APS HEPA filters and the ventilation blowers.

The filters, WL-154 and -155, are located in the off-gas blower room of CPP-604. The prefilter (WL-154) is similar to the ventilation air prefilter and is contained in a 20-in.-diameter stainless steel vessel. The single 8 x 8 x 5 1/4-in. HEPA filter, rated at 70 cfm, is contained in a stainless steel caisson. The specifications for this filter are the same as those for the ventilation air HEPA filters, with the additional requirement of being acid and moisture resistant. These systems are intact but valved out.

During normal operation, E-cell operated two oxygen analyzers and two hydrogen analyzers, located in the west sample corridor of CPP-601. These analyzers monitored O_2 and H_2 concentrations in the E-DOG system. An orifice meter measured the flow rate through the header. Off-gas was moved through the O_2 and H_2 analyzers by a nitrogen jet that discharged to the off-gas header.

6.2.2.5 <u>Aluminum and Stainless Steel Dissolver Off-Gas Systems</u>. Dissolution of aluminum-clad and stainless steel clad fuels produced off-gases at about 20 cfm and 50 cfm, respectively. PSD Sections 5.1 and 5.4 describe these processes. The primary gases evolved during dissolution were nitrogen oxides, radioactive particulate, and radioactive gases. Hydrogen was present as a minor component. The off-gas was diluted with air to recover acid and reduce potential explosion hazards.

The G-cell aluminum dissolvers (G-101 and -151) were exhausted via the CPM-DOG line. This line went directly to the CPM DOG (CPP-604) cleanup systems with the option to valve the G-101 and -151 effluent to the RGP for krypton recovery. The CPM DOG also exhausted gases from the electrolytic process (stainless steel dissolution) in Cell 5, the Multicurie cell, the G-cell Cave, the H-130 evaporator, and the Hot Pilot Plant. The G-cell aluminum dissolvers now vent to the VOG. They (G-101 and -151) can, however, be valved into the CPM DOG or the C-cell and D-cell DOG.

6.2.2.6 Sample Off-Gas. The SOG system is a subsystem of the CPP-601 ventilation system. It is a low volume system designed to keep the sample stations, located in the east and west sample corridors, at a lower pressure than the sample corridors. The sampling systems and the SOG remain functional for their use during D&D operations.

A majority of the CPP-601 sample galleries (installed in the early 1950s) have been replaced by the addition of three shielded sampling cubicles. These cubicles can draw samples from vessels located in process cells F, G, H, L, M, C, E, and D and cell-5. In addition, a glovebox was installed to transfer samples from other sample galleries to the RAL via a pneumatic transfer system. The same pneumatic system is utilized in the cubicles. A complete description of these cubicles can be found in PSD Section 9.1A.

The cubicle and glovebox exhaust systems tie into the existing CPP-601 ventilation system, which is designed to route air from radioactively clean areas to those of higher contamination. The airflow, in the sample corridors where the three cubicles and glovebox are located, is from the operating corridor into the south end of the sample corridors and into the vent tunnels for subsequent exhaust through the ventilation side of the APS. A fraction of this airflow enters the cubicles and glovebox to provide a relative negative pressure to the sample corridor. The exhaust from the cubicles is filtered through one filter located in the cubicle and two external HEPA filters in series. The glovebox is also provided with two in series HEPAs but does not have a prefilter.

Sampler jets and airlifts vent to the vessel from which the sample is being taken. These gases are, in turn, vented to the CPP-601 VOG system. The vessels and VOG are maintained at a negative pressure relative to the sample cubicle.

The remaining older sample stations sample less hazardous process vessels. Air is drawn from the sample corridors into the sample stations through narrow slots in the sampler shielding. The air is then drawn through 2-in. lines that direct it to 4-in. headers located in the east and west ventilation corridors.

The SOG from CPP-641 connects in CPP-640 and is routed via a 1-1/2-in. off-gas line from the samplers to the 4-in. header in the vicinity of the E-cell. The header then carries the gases into the SOG blower room, which is located in the southwest end of CPP-601. The SOG is passed through one of two blowers and then is exhausted into the west ventilation corridor.

6.2.3 CPP-666, FAST Facility

With the change in ICPP mission, fuel dissolution will no longer be done at the FAST facility. The Fuel Storage Area (FSA) portion of the ventilation system is still operational and required during fuel storage.

A complete description of the FAST off-gas systems within CPP-666 can be found in PSD Section 5.6. The portion of the off-gas (FDP) that was directed to the Main Stack (CPP-708) now vents to the FAST stack.

6.2.3.1 FDP Dissolver Off-Gas. The DOG system has, with the change in mission, been cut, capped, and isolated to prepare for D&D.

6.2.3.2 Ventilation and Process Off-Gas. The FAST Facility utilized initially two separate flow systems for the treatment of radioactive process and potentially radioactive ventilation off-gases; one system handled the DOG from the three dissolution trains, and a separate treatment system exhausted the ventilation airflow. With the cessation of fuel processing, the normal route for all FAST airborne effluent is from the FAST stack.

A complete description of the FAST ventilation and off-gas systems can be found in Section 5.6 of the PSD.

6.2.4 CPP-604, CPP-605, and Waste Treatment Buildings

Ventilation air drawn into CPP-604 and supplied via air handling unit AHU-UTI-5503 from the outside enters corridors, flows into the cells, and then exits into a ventilation tunnel. The ventilation tunnel encircles the CPP-604 building and discharges into the main air duct that runs from CPP-601 to the HEPA Building (CPP-649).

VOG from vessels within CPP-604 and the Tank Farm are combined in the VOG mist eliminator. They then receive filtration prior to release to the stack.

6.2.5 CPP-627, Remote Analytical Facility, Decontamination Development Lab, Hot Chemistry Lab, and Emission Spectroscopy Lab

Three different airflow paths exist in CPP-627. The first path runs from ceiling vents, through floor vents into remote analytical equipment boxes that contain highly radioactive samples, and out into the CPP-601 west ventilation tunnel. The second path is through diffusers in the south wall of the second floor analytical laboratory, through six hoods and three gloveboxes, through roof filters, and out the roof exhaust. The third path is from the mechanical room on the roof, into the hot chemistry laboratory, the multicurie cell room and the decontamination room, through a mist eliminator and HEPA filters, and then to the atmosphere.

6.2.6 CPP-684, Remote Analytical Laboratory

The RAL, CPP-684, provides analytical support for radiochemical processes conducted at ICPP and replaces the Remote Analytical Facility (RAF) located in CPP-627.

All RAL effluent is exhausted from a dedicated stack with an on-line monitor and sampling station. A detailed description of the ventilation systems at the RAL can be found in PSD Section 4.10A.

6.2.7 CPP-659, New Waste Calcining Facility

Two major types of gaseous waste are handled at the NWCF: 1) POG and 2) building ventilation off-gas. POG is routed to the POG APS and out the Main Stack. Ventilation air is directed through a rooftop stack at the NWCF.

The NWCF POG system is designed to remove particulate and volatile ruthenium compounds carried out of the calciner, in the off-gas. After passing through the final NWCF HEPA filters, the off-gas travels underground to the APS and out the ICPP stack. POGs carry a high moisture loading. HEPA filters are subject to damage from water. Therefore, the POG is further treated at the POG APS to remove large diameter aerosols from the waste stream to protect the filter systems from failure due to moisture loading.

Ventilation flows and systems exhausting from the NWCF stack are described in PSD Section 8.2.

6.2.8 CPP-633, Waste Calcining Facility (WCF)

The WCF is currently idle but has not been decontaminated. Approximately 800 cfm of off-gas is provided in the WCF for contamination control. The WCF off-gas system consists of three streams. Two streams maintain the required vacuum on the calciner process vessels, waste vessels, hot sumps, sample stations, and other primary confinement systems and vessels. The other system provides for building and cell ventilation.

The equipment off-gas stream is filtered by HEPA filter F-WC-2722 and exhausted by blower WC-252. The POG stream is filtered by one of three HEPA filters, F-WC-2718, -2723, and -2724, in parallel service and exhausted by blowers WC-251-A and -B. Due to the shutdown state of the WCF and reduced off-gas flow, blowers WC-251-A and -B are not used currently. Blower WC-252 is currently out of service. Vacuum on the primary confinement is maintained by the POG APS blowers (OGF-213 and -214). While the vacuum is sufficient to maintain contamination control during normal shutdown situations, the POG systems of the NWCF, the WCF, and other systems serviced by the POG APS are interconnected at the POG APS. This provides a minimum vacuum in the primary confinement, which is adequate for an inactive facility. Process upsets at the POG APS could cause pressurization of the WCF. Additional contamination of the cells could occur. These areas are already contaminated and are scheduled for D&D.

Prior to D&D in the WCF, a safety analysis for D&D will be completed. The safety analysis will determine the configuration of the ventilation and off-gas systems during D&D.

Off-gas from the solids storage in the WCF area is filtered by HEPA filter F-WCS-2721 and drawn into the APS by the APS exhaust blowers, BLO-213 and -214. Pressure relief valves on the solids storage systems relieve pressure buildup into the exhaust line.

The ventilation air (secondary confinement) in the WCF flows from occupied operating areas, through the process cells, and out into the main exhaust blower (WC-3302) to the APS. A description of the CPP-633 ventilation system is given in the WCF SAR, PSD Section 8.3A.

6.2.9 Solids Storage Bins, Vent Off-Gas

The solid waste calcine from the NWCF is stored in the large solids storage bins. These bins are isolated and cooled within vaults. The exhausts are monitored for increased radioactivity. The design of bin and vault cooling and filling systems and the associated ventilation systems are described in Section 8.3 of the PSD.

6.2.10 CPP-640, Headend Processing Plant

CPP-640 Headend Processing Plant (HPP) has several exhaust systems. The five process cells are vented through the HPP vent corridor to the CPP-601 west vent corridor. The VOG, SOG, and DOG systems in each cell are connected to respective systems in CPP-601. The rest of the ventilating air in CPP-640 is exhausted to the atmosphere via the roof exhaust systems. A description of the CPP-640 ventilation system is given in PSD Section 4.2.

6.2.11 CPP-620, High Bay Laboratory, CPP-637, Low Bay Laboratory

Off-gas headers in each of these buildings exhaust off-gases from experiments. These headers combine together and exhaust from the roof of CPP-637 or to the CPP-708 stack. Ventilation air is exhausted to roof stacks. A description of the CPP-620 and CPP-637 ventilation systems is given in PSD Section 4.2.

6.2.12 CPP-603, Fuel Storage Facility, Irradiated Fuel Storage Facility

The Underwater Fuel Storage Facility is not served by a contamination-control or filtered-exhaust type ventilation system. There are no systems that are routed to the Main Stack or the APS systems.

The Irradiated Fuel Storage Facility is utilized for the dry storage of irradiated graphite matrix fuel assemblies. The ventilation for this facility is designed to maintain adequate cooling to control the decay heat produced by the stored assemblies and to control any contamination that might be encountered in the unloading and storing of the individual assemblies.

A complete description of this system and the associated accident conditions resulting from various failures of the cooling and ventilation flow is found in PSD Section 4.12.

6.2.13 Liquid Effluent Treatment and Disposal Facility

The purpose of the LET&D Facility is to reduce the PEW evaporator condensate liquid volume. With a reduced volume, the slightly radioactive and acidic contaminated PEW condensate is not released to the service waste and percolation ponds. The process reduces the volume of the PEW condensate liquid by distillation and concentrates the nitric acid, which improves the management of the liquid as a waste. The concentrated solution is sent to the Tank Farm for storage and processing through the NWCF, or the waste can be sent directly to the NWCF for use in the calciner off-gas scrub. A complete description of the process can be found in the PSD Section 8.6A.

The LET&D process has several heaters to provide protection for HEPA filtration units and to minimize condensation in the CPP-708 Main Stack. Condensation can cause the plugging and failure of the off-gas sample filters or can cause the sample to be scrubbed out of the sample stream inside the sample lines. Heat-traced sample lines reduce the formation of condensate in the sampling system. Blower WLQ-289 and -298 provide the motive force for the movement of the LET&D POG. Blower BLO-WL-297 moves the effluent through the stack heating system.

Water traps, caused by condensation in the line bends and horizontal tubing runs that can scrub the sample stream of its particulate loading, may have occurred during preoperational testing of the LET&D process. This testing resulted in a flaking off of slightly contaminated ammonium nitrate that had collected on the stack wall. The flaking off of the material was caused by the increased heat and moisture inside the stack. The material was released from the stack as a result.

The old stack monitor was operating simultaneously with train 2 of the new stack monitor. The new monitor detected the release while the old monitor did not. The new monitor was designed per ANSI standards with consideration given to line runs and bends. The older monitor is not designed to these criteria. A plausible, though unverified, reason for the detection anomaly could be increased condensation within the sample lines and filter housing of the older sampling system, which did not occur in the newer design.

High moisture content can also cause an increase in the pressure differential across the sample filter. This changing differential can alter the collection efficiency for the complete range of particle sizes. As the filter increases in differential, larger particles tend to be more readily collected. If the pressure differential becomes too great, the filter may tear or disintegrate, causing the sample to be lost.

6.2.14 Laboratory Ventilation Hoods

Laboratory hoods located in CPP-627 and CPP-637 and their ventilation systems are described in PSD Section 4.10A. Noxious and radioactive materials are handled in hoods in very small quantities; consequently, hood exhausts are filtered and discharged through short stacks above the building roofs.

In 1986, significant modifications were completed in the laboratory exhaust systems in CPP-602. A flow diagram for these areas is included as figure 12. The exhaust streams from hoods and gloveboxes, located on the first floor, are now separated from those on the second floor. Ten hoods in the basement area (rooms 103A, 103B, and 103C) are manifolded together and exhaust through stainless steel ducting to the roof of an adjacent building (CPP-630) via blower UTI-242. A glovebox in room 109 and two hoods and a glovebox in room 325 on the third floor of CPP-602 also exhaust through this blower to the roof of CPP-630. Two banks of HEPA filters in series are provided upstream from the blower. In addition, all gloveboxes within CPP-602 are provided with filters in line with the ducting from the box.

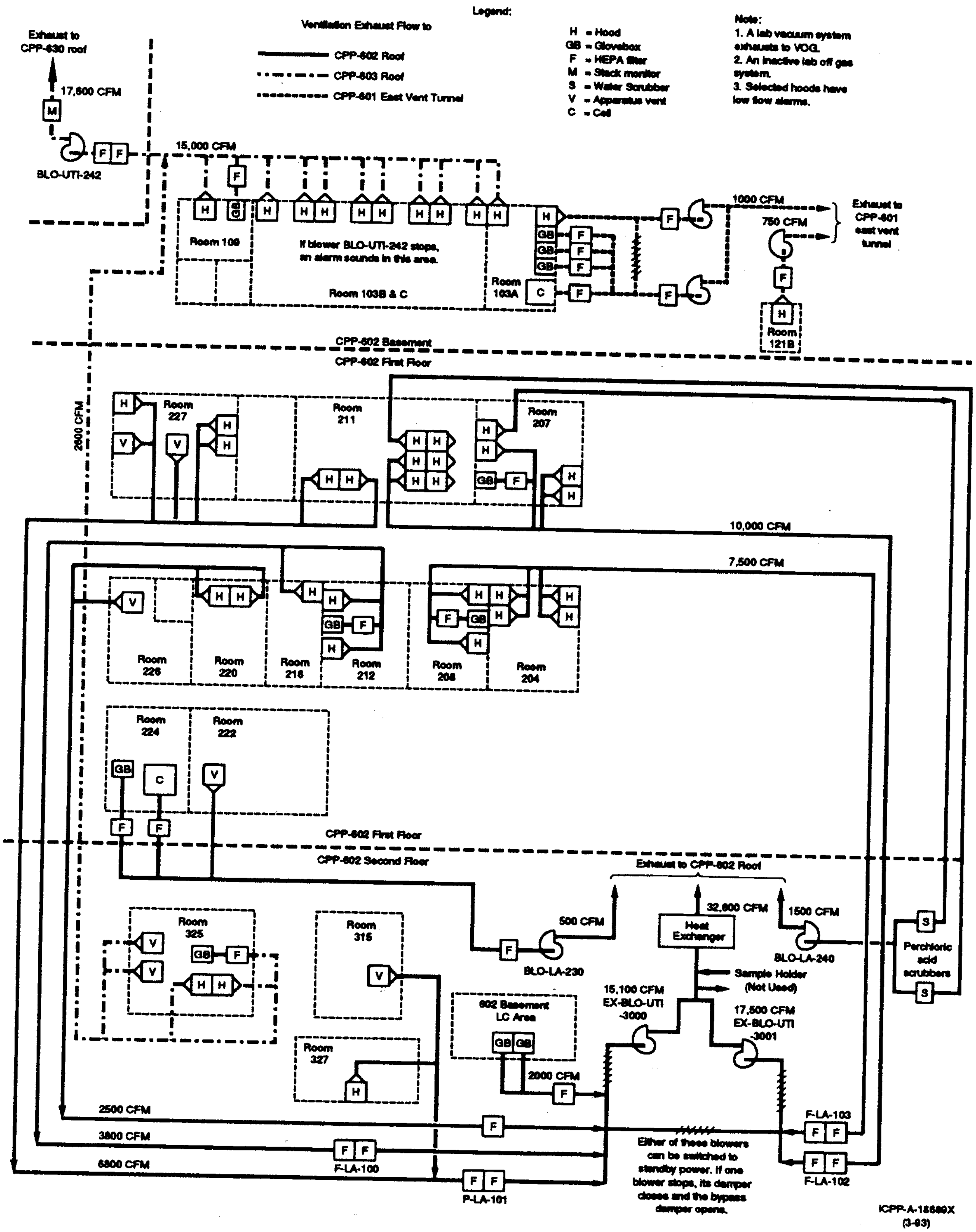

Figure 12. CPP-602 Radioactive Exhaust Systems

Downstream from the blower, a sample line withdraws a sidestream at about 4 cfm. This stream can be passed through a fixed filter that can be periodically removed for analysis. Should blower UTI-242 fail, an alarm sounds in the 103 area labs to alert personnel to the loss of flow into the workstations serviced by the blower.

In addition, room 103A has a hood, three gloveboxes, and the alpha handling cave, which exhaust, after filtration, to the CPP-601 East Vent Tunnel. A hood in room 121B exhausts, after filtration, through a different duct to the East Vent Tunnel. The cave, as with all gloveboxes in CPP-602, is provided with an additional filter in line with the exhaust from the cave interior. HEPA filtration is accomplished prior to the stream entering the vent tunnel. Final filtration for vent tunnel streams is accomplished at CPP-649, Atmospheric Protection Building.

All labs and gloveboxes on the main floor of CPP-602 exhaust to the roof of CPP-602. Selected hoods are provided with flow alarms to alert personnel to a blower failure and loss of hood face velocity.

On the main floor, two hoods (one each in rooms 207 and 211) exhaust via a dedicated blower, LA-240. Upstream from this blower, each hood exhaust is treated by perchloric acid scrubbers.

Room 224 on the main floor contains a glovebox and a cave. The exhaust from these is also routed through a dedicated blower (LA-230) after filtration and is exhausted to the roof of CPP-602.

Remaining hoods and gloveboxes in CPP-602 (including the product loading glovebox and product handling glovebox in the denitrator area) are exhausted through one of two blowers (UTI-3000 and UTI-3001) after filtration and from here through a heat exchanger and to the CPP-602 stack. A side stream sample can be drawn for analysis. Either of these blowers can be switched to standby power. If one blower fails, its damper automatically closes, and a bypass damper opens. These gloveboxes are used for the handling of highly enriched uranium (HEU). There are no monitors that would detect an accidental release from the CPP-602 stack. A criticality would, however, be detected by monitors [i.e., criticality alarm system (CAS), constant air monitors (CAMs), etc.] in the area fulfilling the requirement for timely notification.

During experiments, vapors from volatile organic solvents are released through the laboratory hoods. Mixing of the vapors with large volumes of air prevents these vapors from accumulating. Because radioactive materials are present in some of the hoods, exhaust air from all Type II and Type III hoods (see PSD Section 4.10A) is passed through HEPA filters before it is released to the atmosphere.

As an added safety measure, standard operating procedures (SOPs) ensure compliance with air velocity requirements by requiring periodic airflow surveys of all laboratory hoods. These SOPs also define the required flow rates for satisfactory operation.

6.3 INTERCONNECTIONS

Because the POG systems provide a primary confinement system for process vessels and the ventilation system provides a secondary confinement system, these systems are interconnected based upon the level of confinement. VOG systems, for example, are manifolded together before they are routed to the exhaust point. PSD sections describing the appropriate process detail these specific off-gas interconnections between the vessels.

Ventilation systems of some facilities are unique to that process or facility interconnections to systems from other areas. Examples of these include the FAST Facility, the NWCF, the RAL, and CPP-637. Other systems combine ventilation flows and are exhausted from a single stack. An example of this condition is the variety of process areas that exhaust from the Main Stack. The Main Stack also exhausts many of the process and VOG streams, which combine at the APS. These connections have been described in section 6.2.

The ventilation and POG APS systems bring together several different processing and ventilation flows from CPP-601, CPP-604, CPP-633, CPP-640, CPP-659, the LET&D, and other areas for release from the Main Stack (refer to figure 3 for these connections). Process conditions in one of these areas can create unsuspected consequences in the off-gas systems and may, in some cases, have impacts on other facilities. For example, given the present status of the WCF, an upset in the APS POG caused by an upset in the NWCF could conceivably pressurize the primary confinement at the WCF. A leak from the primary confinement would be contained within the secondary confinement. Contamination released from the primary confinement would not be released from the building.

Another example of unsuspected consequences from these interconnections was discovered during the cold testing of the LET&D Facility in 1992. Steam injected into the Main Stack from this process caused the flaking of known ammonium nitrate deposits from the stack. While the consequences of this event had been described and accepted in a prior SAR, the mechanism was not realized until the event occurred.

For these reasons, process or configuration changes that can affect other processes must be evaluated. This is currently accomplished internally by evaluating the proposal through the unreviewed safety question procedure,[31] which implements DOE Order 5480.21. After the evaluation, further checking is accomplished using engineering change boards and internal review systems. A system similar to this was used to evaluate ammonium nitrate deposits in the Main Stack to determine what, if any, processes could be operated before the ammonium nitrate was cleaned from the stack.[32]

6.4 MONITORING SYSTEMS

6.4.1 Theory of Operation

A comprehensive program for airborne effluent sampling and monitoring is established with the following objectives. A monitoring program should provide 1) data allowing a determination of the magnitude and nature of any environmental airborne release, 2) the ability to quantify that release, and 3) the ability to use that quantification to demonstrate that the total airborne releases within a given period are within limits established by state and federal agencies. The monitoring program should consider both normal operating conditions and accident conditions.[33]

For new facilities and construction and for facilities and systems that are being "significantly modified," DOE has established criteria (DOE Order 6430.1A) to be used in the design of monitoring equipment. The upgrade to the new monitoring system is not considered to have been required to meet all the requirements of a "significant facility modification." Therefore, while the monitor at the Main Stack is considered a "safety class system" by virtue of the consequences of a release from that point, the stack does not meet all the requirements of such a system. The stack does, however, meet most of them. Effluent monitoring equipment may be classified as safety class equipment based upon the magnitude of the potential environmental release. The DOE order specifies that "safety class items are systems, components, and structures . . . whose failure could adversely affect the environment or the safety and health of the public."[2] Included in that definition are those systems that are required to monitor the release of radioactive materials to the environment during and after a DBA. The facility design provides attenuation for postulated accidents (up to and including DBAs) that preclude off-site releases that would cause doses in excess of the DOE 5400 series limits for public exposure.

Environmental monitoring requirements are based upon a graded approach determined by the potential TEDE to the nearest member of the public. These graded requirements are determined from limits and requirements specified in DOE Order 6430.1A, DOE Order 5400.5, and DOE/EH-0173T. The most stringent requirement is for those systems that are determined to be safety class (DOE Order 6430.1A). Safety class monitors are those that monitor processes where there is a potential release from that process that could cause a member of the public to receive an TEDE greater than the DOE Order 5400.5 limit of 10 mrem/y through the airborne pathway.

Safety class monitoring systems must meet the following requirements:

1) In accordance with requirements to verify a release, sampling and monitoring of these release points shall be performed to be completely redundant for radionuclides. Diversity between the two systems is preferred but not required.

2) Sampling of the effluent shall be accomplished with an isokinetic probe where the sample contains particulate releases.

3) Sampling equipment shall be designed to provide its safety function through the DBA.

4) Sampling equipment and instrumentation shall be provided with an emergency power system, which can be UPS.

Specific monitoring requirements are enumerated in DOE Order 6430.1A for each type of facility. There are special sections for hot laboratories, irradiated fuel storage facilities, reprocessing facilities, etc. Monitoring in each of these facilities is required to meet certain specifications. Further guidance in the design of effluent monitoring systems is given in ANSI N13.1 1969, 40 CFR 61, and DOE/EH-0173T.

The graded system of requirements includes not only the requirements for safety class equipment. The system also establishes criteria for monitoring equipment and sampling requirements for release points having less potential impacts. Monitoring requirements specified in DOE/EH-0713T (also based upon effective dose equivalent to the public, and for nonsafety class systems) are shown below:

Calculated TEDE (H_E) mrem/y	Minimum Emission Monitoring Criteria
$H_E \geq 1$	1) Continuously monitor emission points that could contribute $\geq$ 0.1 mrem in a year.
	2) Identify radionuclides that contribute $\geq$ 10% of the dose.
	3) Determine accuracy of the results ($\pm$% accuracy and % confidence level).
	4) Conduct a confirmatory environmental survey annually.
$0.1 < H_E < 1$	1) Continuously monitor emission points that could contribute $\geq$ 0.1 mrem in a year.
	2) Identify radionuclides that contribute 10% or more of the dose.
	3) Conduct confirmatory effluent monitoring at emission points where possible.
	4) Conduct a confirmatory environmental survey every few years.
$H_E < 0.1$	1) Take periodic confirmatory measurements.
	2) Test to determine need to monitor by calculating dose (H_E) for normal operation, assuming that the emissions controls are inoperative.
	3) Conduct a confirmatory environmental survey at least every 5 years.

The above requirements are basically the same as those specified in federal codes (40 CFR 61). They indicate that continuous monitoring is required for all ARPs that could contribute greater than 0.1 mrem in any 12-month period. The criterion for periodic confirmatory measurements is determined from calculations (confirmed by periodic sampling) based upon no mitigating factors during normal operations. It is important to recognize that these requirements are for instrumentation used to measure normal operational effluent when all mitigation factors are excluded from the calculations. The criterion do not address accident conditions or the criteria for safety class monitoring systems.

Analyses used to establish operating limits are based upon particulate releases and have been evaluated using the RSAC-4 computer code. This code has been used to model airborne releases that could cause an exceeding of the normal operational limits over various release periods for both normal and upset (accident) conditions. These calculations are used to determine the instrument settings required to ensure that ICPP releases support both the environmental requirements and the requirements of the safety envelope.

Total airborne radioactive particulate activity from ICPP operations is normally only a few millicuries per day. Total radioactivity (particulate and nonparticulate combined) was examined for each of the ICPP processes for the years 1980 through 1989.[34] These total releases were analyzed and a calculation was derived to determine the total number of curies of activity that would be released from each process should that process operate continuously for 1 year. Such a situation is not expected to occur as normal processing campaigns are of a shorter duration. Additionally, most processes are inactive and there are no plans to resume those terminated. The subsequent total TEDE was calculated for four locations including the nearest site boundary. These doses are reported in this PSD section and range from 5.55 E-04 mrem for the second- and third-cycle process to 1.21 E+00 mrem for fluorinel dissolution processes. These doses include doses received from both particulate and nonparticulate releases. Some of these processes (i.e. dissolution) will not be operated in the future due to the change in mission for the ICPP. These data are included (as well as decontamination data) to provide a reference for future D&D activity. The criteria upon which limits have been determined are based on off-site dose criteria specified in 40 CFR 61, Subpart H, and DOE 5400.5.

Procedurally, all airborne radioactive release points at the ICPP are monitored or the releases are calculated. Monitoring requirements are based upon the impact of that release to the regulatory levels and the criteria specified in 40 CFR 61. The total release of radioactivity (both particulate and nonparticulate) includes the summation of all ICPP release points and will not cause the maximum individual risk (MIR) in the public domain (off-site) to receive an TEDE greater than specified limits in any consecutive twelve-month period. A cumulative, running total of the emission inventory is kept. Nonparticulate activity is measured or calculated, and the calculated dose from these isotopes is added to the particulate analysis and is included in the cumulative total.

Liquid radioactive wastes are occasionally received from other INEL operations to be processed through the PEW evaporators. The off-gas from the PEW is released through the Main Stack. Procedurally, these shipments require a radionuclide analysis to determine the particulate and nonparticulate processing releases from the spectra of the shipment. Shipments may be refused to allow for the decay of I-131 before processing.

I-131 is received from other INEL installations as a constituent of radioactive liquid waste shipments from reactor areas. Unusual and unpredicted releases, should they occur, would be released from the Main Stack and would normally be sampled by the gaseous sampling equipment installed in the Main Stack monitoring building (CPP-692).

Another nuclide of concern is Ru-106. It can be volatilized in the NWCF.[35,36] Adsorbers have been installed to remove it from the effluent, and stack sampling will detect any unusual release.

In support of recent reductions in allowable releases, an analysis was done in 1986[37] to ensure that normal operations would provide compliance with dose standards applicable at that time and to formulate internal specifications to ensure compliance with the standards. The analysis utilized worst-case meteorological conditions over a 24-hour period. The analysis also indicated that these particulate releases would not cause the off-site receptor to receive a dose in excess of the standards during the prescribed release period, given these meteorological conditions. The internal specification was further reduced by 0.1 Ci in each case. Due to the reduced standard of 40 CFR 61 published in the Federal Register, December 1989, this calculation was recently verified[38] to determine whether ICPP internal compliance is still valid.

The verification used worst-case conditions for the safety limits (SLs) and annual average meteorological data for the limiting conditions for operation (LCOs) and the limiting control settings (LCSs). A recently updated meteorological model and a recent version of the modeling program was used for the analysis.[39]

The analysis indicated that an average release of 3.21 E-03 Ci/h from the Main Stack and 1.87 E-03 Ci/h from the FAST stack would result in an TEDE at the site boundary of approximately 1.0 mrem for a consecutive 12-month period. Actual historical data indicate that the average site boundary TEDE from Main Stack releases is 6.6 E-4 mrem/y and 4.9 E-01 mrem/y from the FAST stack using the same modeling assumptions. Twenty-four hour releases from each stack were calculated using a value of 6.7 Ci from the Main Stack and 6.3 Ci from the FAST stack. These calculations utilized 95% meteorological conditions as determined by the National Oceanic and Atmospheric Administration (NOAA).[40,41]

The site boundary TEDE for the Main Stack release of 6.7 Ci was calculated as 3.92 E+00 mrem, and for the FAST stack release of 6.3 Ci, the TEDE was 7.32 E-03 mrem. The differences result from differences in the effective stack height, different nuclide term, and the effect of analyzing acute releases using 95% meteorology.

One such release from either or both the Main Stack and the FAST stack could occur in a given 12-month period before the limits were challenged. Even one such release from the Main Stack would allow normal operations at the usual emission rate to continue for the following 12-month period. This is true because actual releases from normal operations are usually considerably lower, as described above. Limits set as a result of the 1986 analysis are considered to be sufficiently conservative that an adequate safety margin is maintained using these same limits. These calculations are explained in greater detail in section 8.

In addition to the upscale alarm points, downscale failure alarm points are provided on the various monitors. Alarms at the downscale points indicate failed detectors, electronics failure, failed filters or collection beds, or any system failure that causes downscale movement of monitor readouts. Upscale alarms are almost always indicative of an increase in radioactivity, but can be caused by a failure such as an electrical short.

6.4.2 Equipment Description

Descriptions of monitoring equipment for the FAST, RAL, and NWCF ventilation stacks are found within their respective PSD sections. The Main Stack monitor description follows below.

The Main Stack monitor is designed to comply with ANSI N13.1 and 40 CFR 61 requirements for effluent monitoring. The instrumentation includes a two-train sampling and monitoring system.

All electrical components necessary for operation of the isokinetic sampling system and stack effluent monitoring equipment are provided with standby power. Supports for the isokinetic sample lines were designed to UBC, Zone II requirements with an importance factor of I.

6.4.2.1 Train 1, Train 2 Monitor. In terms of the isokinetic, particulate sample, both Train 1 and Train 2 are identical. The following description is for each of the two trains. Each item described is included in each train. Differences occur between the two trains in other monitoring capabilities. Special equipment is in place on one or the other trains for volatile species. These samples are not required by safety analysis but are used to evaluate trends in various processes and, in some instances, to provide additional information required by the EPA for reporting purposes only and not for maintenance of the safety envelope.

A sample of stack effluent is continuously withdrawn from a sample probe located 90 ft above the base of the stack. The 1.5-in.-diameter sample probe extends approximately 93 in. into the stack and includes eight 3-in.-long sample nozzles. The nozzles are pointed directly into the downstream direction of gas flow and are positioned in the center of four equal annular areas, in compliance with ANSI requirements.

The sample probe rake is equipped with six mass flow sensors. The total stack flow rate is determined from the average flow measured by the six mass flow sensors and the cross-sectional area of the stack. ***The sample is nominally isokinetic and the sample flow is proportional to the main stack flow. Signals from the six mass flow sensors, as well as the stack gas flow, are recorded on the distributed control system (DCS), a process control system with terminals located in the control room of CPP-604.***

The sample is transported to the monitoring building (CPP-692) via a 120-ft-long by 3-in.-diameter seamless stainless steel sample line. ***The line is heat traced and controlled at a temperature above the temperature of the stack effluent to prevent condensation inside the line.*** The sample line is designed with large radius bends and limited horizontal sections of 30 ft or less to minimize potential sample losses.

The total velocity of the sample withdrawn from the stack is controlled to maintain near isokinetic velocity. The measured stack flow from the six thermal mass velocity flow sensors is compared to the total sample flow rate measured by two in-line flow sensors located in CPP-692. ***Signals from the two in-line sensors are recorded on the DCS. The total sample flow rate to total stack flow is maintained at a nominal ratio of 1 to 8000.***

In CPP-692, the total sample flow is split into two separate streams. ***One stream goes into the bulk particulate filter and from there through other monitors unique to each train. The sample to stack flow ratio for this stream is a nominal 1:10,000. The other stream passes through the on-line particulate radiation monitor and from there through additional downstream monitors unique to each train. The sample to stack***

flow ratio for this stream is a nominal 1:40,000. Both streams are returned to the stack after sample collection and monitoring.

The bulk particulate sample is a 6-in. diameter polypropylene HEPA filter for the collection of particulate samples. It is used for the documentation of particulate releases from the Main Stack. ***Flow control valves (one per stream) maintain a proportional flow to each stream.*** With a proportional flow, the system design guarantees that the sample is isokinetic.

The bulk particulate filter is changed on a weekly basis. The weekly filter is combined with a 2-in. diameter filter from the on-line particulate monitor and is analyzed for gamma emitting radionuclides. The weekly filters are composited on a monthly basis. Monthly composites are analyzed for Plutonium and are prepared from the weekly composites following separation and analysis for radiostrontium.

The other sample stream, as described above, first passes through the on-line particulate monitor. The primary purpose of the monitor is to provide a real-time estimate of the particulate component of the stack effluent to ensure that the limits specified in the safety document are not exceeded. The monitor consists of a 2-in.-diameter high efficiency sample filter and a sodium iodide scintillation detector with an alarming ratemeter. Signals from the sample flow sensor and the ratemeter are recorded on the DCS and on the radiation and environmental safety (R&ES) computer for display at the ECC. ***The system is alarmed to provide a timely signal to operators when excessive amounts of particulate activity are detected.***

The frequency of changeout for the 2-in. filter is at least weekly.

A gaseous sampler provides documentation of the gaseous releases from the ICPP Main Stack. The flow rate through the system is continuously measured using a mass flowmeter.

The gaseous sampler uses a single adsorption bed. for time-integrated collection and on-line measurement of I-129. The frequency of changeout of the adsorption media is twice yearly, and they are submitted under chain of custody for analysis of I-129.

7. WASTE MANAGEMENT

The ventilation and off-gas systems generate limited amounts of liquid-waste primarily in the form of condensates and liquids, which are removed in mist eliminators and condensers. This waste is disposed of to the PEW system. After processing in the PEW, the resulting bottoms solutions are sent to the Tank Farm for future calcination. Slightly contaminated water from the condensate overheads is sent to the LET&D facility where the water is vaporized and sent to the Main Stack for release as a vapor. The LET&D off-gas is superheated prior to release to prevent the formation of condensates from the process.[42]

Solid wastes in the form of contaminated HEPA filters are removed from the filter housings, packaged as appropriate to the level of entrained activity, and disposed of to the Radioactive Waste Management Complex (RWMC) or are retained for future leaching of contamination in the filter-leaching process at the NWCF. Section 4.4 of the PSD describes the handling of solid radioactive waste including contaminated HEPA filters.

Other solid wastes are generated in the form of protective clothing worn while working on or changing filters in the ventilation and filtration systems. Contaminated protective clothing is normally handled as low-level contaminated waste and is discarded or cleaned for reuse.

Small quantities of waste, both solid and liquid and radioactive and nonradioactive, are generated when the stack sample filters are analyzed. These wastes are disposed of according to laboratory procedures.

8. NORMAL OPERATIONS

This section describes the controls and procedures used to limit the release of airborne radioactive materials to the environment and to control occupational doses received by personnel working on the systems or in areas serviced by the system. These controls, when implemented, limit doses to within those specified in DOE/EH-0256T and DOE Order 5400.5.

8.1 CRITICALITY CONTROLS

The off-gas headers are elevated above the vessels to preclude uranium-bearing solutions from entering the gaseous waste systems. In the unlikely event that such solutions are introduced into the off-gas headers, the header and liquid separation equipment is designed to drain to the storage or process vessels as described in the PSD sections for these vessels.

From lessons learned at other facilities, the ICPP initiated a one-time inspection program to determine whether any uranium solids had accumulated in the ventilation ducts. The survey indicated that uranium accumulation in the ducts was not a concern.[43]

8.2 PERSONNEL RADIATION AND CONTAMINATION CONTROLS

The off-gas and ventilation systems collect contaminated gases, direct them away from occupied areas, and filter the effluent before its release. DOE Order 6430.1A specifies that derived air concentrations (DACs) released from stacks cannot be exceeded should the stack plume enter occupied areas. Situations can occur (under certain meteorological conditions) when the Main Stack or the FAST stack effluent could be drawn into building intake systems. Many include CAMs (with the exception of office areas) that would alert personnel in these conditions. Personnel in areas lacking CAMs may be at risk until the activity is detected elsewhere.

In the denitrator area [the CPP-602 Laboratory Building, Lower level, Laboratory C (LC)], the product loading glovebox and the product handling glovebox confinement flows are exhausted to the fan loft, filtered, and released to the CPP-602 roof. The effluent from these boxes is filtered through a single HEPA filter prior to release. A significant fraction of the dose, resulting from exposure to the radioactive cloud from a criticality, results from gaseous constituents that are not removed by HEPA filtration.

The stack on the CPP-602 roof does not have any radiation monitoring equipment. There is a sidestream filter that is not routinely collected and analyzed. The accident of concern is a criticality event, which would be detected by the CAS in the area, initiating an evacuation. After passing through a single HEPA filter, the release from this event could result in exposure of personnel outside the building and be drawn into the ventilation inlets for CPP-601, CPP-602, CPP-606, and CPP-630, or other facilities. The stack height for the release is not sufficient to ensure that the release would be dispersed from the confines of the ICPP. Personnel evacuating from or through these areas could be exposed to the radioactive gases that pass through the areas as a result of the criticality.

8.3 ENVIRONMENTAL EFFECTS

Ventilation and POG systems are not a source of radioactive materials. Ventilation and off-gas systems collect and confine radionuclides generated by other plant processes. The radiological impact of a POG system or a ventilation system is measured in that system's ability to decontaminate the effluent prior to its release from the facility.

Nuclear air cleaning systems are provided to protect the public and plant operating personnel from airborne radioactive particles and gases that are, or could be, generated and released from operations at the ICPP. The component universally included in ICPP systems is the HEPA filter. These filters provide the final barrier between the confined space in which the radioactive materials are generated and the point of release to the atmosphere.

For ICPP safety analysis purposes, various particulate efficiencies are assumed for HEPA filters. No safety credit is assumed for a filter that is not testable, using an approved in-place aerosol test, even though the prefilters might be HEPA filters of similar quality to the final testable stages for the process. The release data for normal operations are derived from actual monitoring data when these filters were intact. Therefore, credit has been taken for normal operations but not for accident scenarios. It is presumed that filters tested at the DOE test center, which subsequently pass an in-place test, will be 99.97% efficient in the removal of particulate activity within the particle size range utilized in the procedure (0.03 μm).[44] During an accident condition, actual filter efficiencies may be somewhat less.

Many of the filter banks (caissons) contain three or four independent filters in series. When the in-place test is across the entire caisson, credit is taken only for one filter stage, even though the effluent passes through additional filters prior to exhausting back into the common vent.

In addition, within a ventilation or off-gas system, there may be other items or equipment that will function to remove particulate from the effluent. Condensers and wet scrubbers are rated at 90% efficiency during both normal and accident conditions, and mist eliminators are rated at 50% efficiency for both normal and accident conditions.[44] Silica adsorbers are also used to process the effluent from the NWCF and are rated as 90% efficient in that process for the removal of ruthenium compounds.[45] In removing the water from these effluent streams, gases and other contaminants that are soluble or entrained in the water are also partially removed.

NO_x can cause HEPA filters to be more susceptible to failure due to moisture. The water repellency of HEPA filters is degraded by exposure to these acidic gases. When required, process filters used at the ICPP are acid resistant, which improves their service in these conditions. Condensers and mist eliminators, when required to remove moisture, may also help by removing a fraction of the acidic gases before they reach the filters. With the use of acid-resistant filters, there is insufficient data to determine whether filter reliability is increased through the use of condensers and mist eliminators. Other factors may limit the desirability of operating moisture removal equipment. The condensates may contain concentrated levels of some radionuclides or hazardous materials that are better left in the gas stream than converted to liquid waste. Operation of condensers and mist eliminators helps to extend filter life. When there are no contraindicating conditions, it is a good practice to provide and operate both condensers and mist eliminators.

Equipment requirements in the ventilation and off-gas systems may vary according to conditions and the process being operated. Equipment requirements are as noted in table 2.

For NWCF operation, the mist eliminators, superheaters, and filter banks in the POG side of the APS are required to be on-line during calciner operations. ***The condenser (OGF-104) is required if the VOG or CPM jet is used to maintain vacuum on the VOG system. Additional requirements for NWCF operation are found in PSD Section 8.2.***

The following discussion details releases of volatile nuclides that have occurred in previous years from the Main Stack. With the change in mission at the ICPP, these nuclides are of far less concern. The NWCF can still volatilize ruthenium, but the quantities available do not constitute significant dose effects on or off-site. The following discussion is included in the PSD to describe actions taken at the time and to identify processes where the releases could occur should the ICPP mission change again.

The NWCF process can volatilize ruthenium compounds that would be exhausted from the main stack. This is particularly true during bed dissolution iterations. On October 30, 1988, a release of 0.17 Ci of

Table 2. Ventilation and Process Operation Gas Equipment Operability Requirements

Equipment ID Number	Function	Operability Requirement
VES-OGF-104	Condenser to remove excessive moisture from process off-gas (POG) when required. Moisture will fail downstream HEPAs.	On-line and operable when vessel off-gas (VOG) or continuous process modification (CPM) steam jet is in use.
HE-OGF-106	Steam superheater installed to raise POG above dewpoint and prevent downstream filter from failure due to large diameter aerosols.[a]	On-line and operable during process operation of the off-gas systems for the NWCF calcine process, VOG, CPM dissolver off-gas (DOG).
VES-OGF-132	Mist eliminator installed to remove large diameter aerosol particles from POG and prevent failure of downstream filters from moisture laden effluent.	On-line and operable during operation of the NWCF calcine process, VOG, CPM DOG.
BLO-OGF-213, -214	APS POG airborne effluent blowers.	One operating during operation of the NWCF calcine process.
F-OGF-100, -101, -102	Final POG HEPA filter.	On-line and operable during operation of APS POG. Will be replaced with new filter bank in near term. Operability for replacement filters is same.
VES-VT-300, -WL-127	Condenser and mist eliminator to remove large diameter aerosols from VOG POG.	On-line and operable during operation of VOG processes.
VES-WL-305	Superheater installed to preheat VOG above dewpoint to protect F-WL-121 from failure due to moisture loading.[a]	On-line and operable during operation of VOG processes.
BLO-WL-209	Vessel off-gas blower.	On-line and operable during operation of the VOG; may be down for periodic maintenance, providing either BLO-OGF-213, -214 is on-line and operating.
F-WL-121	VOG HEPA filter.	On-line and operable during operation of the VOG. Filter may be bypassed for changeout, providing -100, -101, or -102 are on-line and operable. Added dioctyl phthalate (DOP) ports provide testability of this filter as first stage VOG HEPA filter.
CPP-756 Prefilter	Ventilation APS prefilter.	On-line and operable during operation of the APS ventilation system.
CPP-649 ventilation APS HEPA filters	Final ventilation HEPA filters.	On-line and operable, one or more may be bypassed for filter change or to provide backup redundancy.
BLO-WL-210, -211, -212	Ventilation APS airborne effluent exhaust blowers provide vacuum for cell ventilation.	Normally two of the three on-line and operable, one blower required.
BLO-250, 251, Jet WN-550	Exhaust blowers for CPM DOG and Rare Gas Plant (RGP).	One blower or jet on-line during fuel processing operations.

Table 2. (Contd.) Ventilation and Process Operation Gas Equipment Operability Requirements

Equipment ID Number	Function	Operability Requirement

a. Mist eliminators and superheaters normally (but not always) work in tandem depending on requirements at the time. The mist eliminator is designed to remove larger droplets of water. The superheater functions to heat the remaining stream above a point where it will pass through the HEPA filter without damaging it. When the stream is saturated, a condenser is added upstream of the mist eliminator to reduce the total moisture loading. Operability does not necessarily require operation (see text). Processing conditions determine periods of operation.

ruthenium occurred during normal operations (bed dissolution) at the NWCF. The consequent dose (TEDE) from this event did not cause the exceeding of any limits or regulations. Nonetheless, a complete investigation of the event was conducted at a type B level of authority.[46]

As a result of the investigation, it was determined that the silica gel adsorbers at the NWCF had been valved out. The release (being volatile) passed through the filter media. While the release was not significant and no off-site radiation was detected, lessons learned from the event are significant and are reflected in PSD Section 8.2. Operating requirements are in place for the silica gel adsorbers.

Since the startup of the FDP dissolution process in 1986, antimony (Sb-125) has become a major contributor to the total airborne activity found on or near the INEL site. Adsorbers made from silica gel have effectively eliminated these releases. They are no longer required when fuel dissolution is not occurring.

As is true with volatile ruthenium, other nuclides may not be removed from the radioactive effluent by HEPA filtration. These include iodine, carbon, tritium, and krypton. The dose that these contribute to the TEDE has, in the past, been of little significance and, with the change in mission, is of less significance than before. It is possible that I-129, with a long half-life, could accumulate over periods of time as the nuclide has at other laboratories. To date there has been no significant iodine build-up at the INEL.

A preliminary investigation has been initiated to study iodine removal systems. With the change in mission, these systems may not be pursued. While iodine is present in Tank Farm wastes, most of the iodine was released from fuel processing operations.[47] Iodine in the Tank Farm will be released in the future during calciner campaigns. However, because of the cessation of fuel reprocessing, the total annual iodine release from the ICPP will not cause dose limitations to be exceeded from iodine released during calciner operations. Due to the long half-life of

I-129, the INEL program of environmental surveillance should continue to ensure that gradual iodine accumulations are not becoming a potential problem.

As noted in table 2, POG and ventilation APS equipment is normally operated as described. The APS was installed to provide assurance that abnormal conditions occurring upstream in the process areas would not result in an unmitigated release to the environment and that normal operational releases would be ALARA. The original APS upgrade included the addition of 1) the CPP-649 filters; 2) the CPP-756 prefilter; 3) the E-DOG filters; and 4) on the POG side, a fiberglass prefilter (since replaced by HEPA filter OGF-131), the condenser (OGF-104), the mist eliminator (OGF-105, since replaced by OGF-132), the superheater (OGF-106), and the final filters (OGF-100, -101, -102). This system has been modified again as described in section 6.2.1.2. Prior to the modifications completed in the early 1970s, ventilation air was exhausted to the environment with no filtration. The POG was released after one stage of HEPA filtration. Without these final cleanup systems, the radiological effluent from the ventilation and POG APS systems was still within limits imposed at the time. Technical standards established criteria for filter changeout, based upon resultant radiation doses to personnel working on the changeout or upon doses received by personnel as a result of filter failures. These considerations were more restrictive than what were, at that time, public dose limitations. Public dose limits have been significantly reduced. Filter changeout requirements are now usually driven by the effects of contamination releases from totally loaded radioactive HEPA filters. Filter changeout criteria are based upon radiation doses that would be received by the public from near incredible accident scenarios involving the release of all radioactive materials from all the filters in the system over a limited time period.

Failure of any individual component or of the entire APS will not result in unacceptable environmental releases if this is the only failure and if that failure occurs during normal operating conditions. The total TEDE, calculated from a year of operation without any filtration devices on-line, is 8.37 E+1 mrem/y.[23] An entire year's operation with no mitigating factors will not occur. Therefore, while technical specifications will provide assurance that the public dose limits are mitigated during an accident condition, the operability of each individual piece of equipment is determined by standard operating procedures.

Filters for systems that are valved out will be checked before bringing those systems on-line should the decision be made to resume fuel processing activities. Otherwise, the operability requirements for this equipment will be described in SARs devoted to D&D activities.

Filters, mist eliminators, scrubbers, adsorbers, superheaters, and condensers described in this document are required to be operational, in accordance with operational procedures, as described in table 2, and on-line during operation of the systems. Failure of any individual piece of equipment will not cause the limits defined in DOE Order 5400.5 or DOE/EH-0256T to be exceeded. Standard operating procedures describe the action to be taken, given the failure of these items. These procedures are approved by the departments within the contracting company. These procedures are auditable and available to the DOE for independent verification that the safety envelope is maintained by virtue of the procedural requirement. The failure of any single piece of equipment or filter will not cause any dose limitations to be exceeded during normal operations. The ALARA policy, however, dictates that these systems should be normally on-line. In addition, taking these items out of service increases the consequences of accident scenarios. Failure of any individual piece of equipment should be corrected promptly. And, in addition to the ALARA considerations during normal operations, it is assumed that condensers and mist eliminators will provide protection during some accident scenarios, such as fire. Condenser, OGF-104, was designed to cool 174°F off-gas to 75°F. Mist eliminators will remove ash, soot, and other large particles that could cause filter failure from loading. Condensers will cool the effluent stream and provide protection against the HEPA filters failing due to hot gases. High temperatures can cause the filter media to slough away from the filter casing. The filter itself will not fail in higher temperatures. The bank will, however, likely fail an in-place test. In this case total filtration has not been lost, only the efficiency of the filter bank is decreased.

Radioactive effluent streams at the ICPP are passed through at least one stage of HEPA filters before release. The number of filter stages and other equipment through which the effluent is passed depends upon the potential (not actual) significance of an abnormal release from that effluent stream and the chemical nature of the effluent being treated. The collection of these materials on filters and adsorbers results in increased risks to the personnel responsible for the removal and replacement of these media. These risks result from the concentrated contaminants present on the filter media and exist as direct exposure hazards. There is also a risk from the loose contamination present within the filter media. ***Technical specifications and standards enforce the upper limits for radiation exposures based upon radioactive contamination loadings on the filters.*** In setting these limits, consideration is given to the location and personnel access to the filter area and the consequences of an environmental release due to filter failure. Some filters are located in shielded areas with restricted access, and some of these are able to be changed remotely. Operational limits are established in procedures that further reduce the exposure of personnel to radiation fields and keep these doses ALARA.

To accurately characterize airborne releases from ICPP processes, various methods were used to calculate the potential radiological impacts from these processes. These methods are described below and in tables 3 and 4.

Data reported in table 3 were calculated using actual release data contained in the Normal Radioactive Effluent Release Rates reports issued between 1980 and 1989 and include noble and volatile gases. The release rates in these reports were corrected to assume 365 days of continuous operation for each of 12 processes. Some of these processes are currently in an inactive and standby mode and some are scheduled for eventual D&D (e.g., the E-cell dissolution process). These standby or discontinued processes are so noted in table 3. When two or more operations are functional at the same time, the correct release rate can

Table 3. Processes That Contribute to ICPP Main and FAST Stack Effluent

Process	Off-Site dose[a] mrem/y	CFA dose[a] mrem/y	TRA dose[a] mrem/y	ICPP dose[a] mrem/y
Main Stack Effluent				
E-cell Zr dissolution[b]	6.4 E-1	1.4 E-2	5.7 E-3	1.7 E-2
Second and third cycle	5.6 E-4	4.3 E-6	1.8 E-6	5.1 E-6
Rover dissolution[b]	8.2 E-2	5.4 E-4	2.2 E-4	6.5 E-4
Denitration	1.3 E-2	4.2 E-5	1.7 E-5	5.0 E-5
Electrolytic dissolution[b]	1.9 E-2	2.5 E-4	1.0 E-4	2.9 E-4
Coprocessing dissolution[b]	6.8 E-1	1.5 E-2	6.1 E-3	1.8 E-2
Aluminum dissolution[b]	2.1 E-2	4.0 E-4	1.6 E-4	4.8 E-4
601 cell decontamination	3.1 E-3	1.3 E-5	5.1 E-6	1.5 E-5
FAST [during Rare Gas Plant (RGP) operation][b,c]	2.0 E-2	6.8 E-4	2.7 E-4	8.1 E-4
NWCF process off-gas	3.1 E-2	2.2 E-4	8.8 E-5	2.6 E-4
FAST Stack Effluent	FDP Dissolution Prior to Installation of Silica Gel Adsorbers			
FDP[b,d]	1.2	7.4 E-3	3.0 E-3	8.9 E-3
FDP decontamination	1.2 E-4	4.0 E-7	1.6 E-7	4.8 E-7

a. Effective dose equivalent (EDE, includes the committed effective dose equivalent from internal deposition of radioisotopes and the effective dose equivalent due to penetrating radiation from sources external to the body.)

b. Data is from active processes. Processes are inactive and in standby mode or scheduled for D&D. Dissolution of fuel is terminated and systems are isolated for shutdown and eventual D&D.

c. Effluent released from Main Stack during operation of the RGP. No future releases in this configuration. Fuel dissolution is no longer part of ICPP mission.

d. Effluent released from FAST stack when RGP is not operating. Reported values are for active dissolution processes.

Dose is calculated for each process as if it were run continuously for one calendar year. Data is based on effluent collection from Main Stack sample analyses for the years 1980 through 1989.

Table 4. Calculated Doses from Annual Operations for Each ICPP Process

Receptor Location	Inhalation mrem/y	Ingestion mrem/y	Ground Deposition mrem/y	Air Immersion mrem/y	Effective Dose Equivalent mrem/y
FDP Process During Operation of Rare Gas Plant					
Off-site	4.8 E-04	1.7 E-02	4.6 E-05	2.9 E-03	2.0 E-02
Central Facilities Area (CFA)	1.0 E-05		8.9 E-06	5.7 E-04	6.8 E-04
Test Reactor Area (TRA)	3.9 E-05		3.6 E-06	2.3 E-04	2.7 E-04
ICPP fence	1.1 E-04		1.1 E-05	6.9 E-04	8.1 E-04
Electrolytic Dissolution Process					
Off-site	4.9 E-04	1.8 E-02	1.2 E-04	6.4 E-04	1.9 E-02
CFA	9.6 E-05		2.4 E-05	1.3 E-04	2.5 E-04
TRA	3.9 E-05		9.7 E-06	5.1 E-05	1.0 E-05
ICPP fence	1.1 E-04		2.8 E-05	1.5 E-04	2.9 E-04
Coprocessing					
Off-site	5.7 E-02	6.0 E+01	1.3 E-02	7.4 E-03	6.8 E-01
CFA	1.1 E-02		2.6 E-03	1.5 E-03	1.5 E-02
TRA	4.5 E-03		1.0 E-03	5.9 E-04	6.1 E-03
ICPP fence	1.3 E-02		3.1 E-03	1.7 E-03	1.8 E-02
Aluminum Dissolution Process					
Off-site	9.8 E-04	1.9 E-02	8.4 E-05	9.6 E-04	2.1 E-02
CFA	1.9 E-04		1.7 E-05	1.9 E-04	4.0 E-04
TRA	7.8 E-05		6.7 E-06	7.7 E-05	1.6 E-04
ICPP fence	2.3 E-04		2.0 E-05	2.3 E-04	4.8 E-04
Zirconium Dissolution Process (E-cell, CPP 601)					
Off-site	5.4 E-02	5.7 E-01	1.1 E-02	6.4 E-03	6.4 E-01
CFA	1.1 E-02		2.2 E-03	1.3 E-03	1.4 E-02
TRA	4.3 E-03		8.8 E-04	5.1 E-04	5.7 E-03
ICPP fence	1.3 E-02		2.6 E-03	1.5 E-03	1.7 E-02
Second and Third Cycle Extraction Process					
Off-site	1.7 E-05	5.3 E-04	5.3 E-06	1.0 E-08	5.55 E-04
CFA	3.3 E-06		1.0 E-06	2.0 E-09	4.3 E-06
TRA	1.3 E-06		4.2 E-07	8.1 E-10	1.8 E-06
ICPP fence	3.9 E-06		1.2 E-06	2.2 E-09	5.2 E-06

Table 4. (Contd.) Calculated Doses from Annual Operations for Each ICPP Process

Receptor Location	Inhalation mrem/y	Ingestion mrem/y	Ground Deposition mrem/y	Air Immersion mrem/y	Effective Dose Equivalent mrem/y
Rover Dissolution Process					
Off-site	2.4 E-03	7.9 E-02	3.4 E-04	8.3 E-07	8.2 E-02
CFA	4.7 E-04		6.7 E-05	1.6 E-07	5.4 E-04
TRA	1.9 E-04		2.7 E-05	6.6 E-08	2.2 E-04
ICPP fence	5.6 E-04		8.1 E-05	2.0 E-07	6.5 E-04
NWCF Process Off-Gas					
Off-site	9.7 E-04	3.0 E-02	1.4 E-04	1.4 E-07	3.1 E-02
CFA	1.9 E-04		2.7 E-05	2.8 E-08	2.2 E-04
TRA	7.7 E-05		1.1 E-05	1.1 E-08	8.8 E-05
ICPP fence	2.3 E-04		3.3 E-05	3.4 E-08	2.6 E-04
Product Denitration Process					
Off-site	1.6 E-04	1.3 E-02	6.0 E-05	3.5 E-08	1.3 E-02
CFA	3.0 E-05		1.2 E-05	6.9 E-09	4.2 E-05
TRA	1.2 E-05		4.8 E-06	2.8 E-09	1.7 E-05
ICPP fence	3.6 E-05		1.4 E-05	8.3 E-09	5.0 E-05
CPP 601 Process Decontamination with Shutdown					
Off-site	5.1 E-05	3.0 E-03	1.4 E-05	8.2 E-09	3.1 E-03
CFA	9.9 E-06		2.7 E-06	1.6 E-09	1.3 E-05
TRA	4.0 E-06		1.1 E-06	6.6 E-10	5.1 E-06
ICPP fence	1.2 E-05		3.2 E-06	1.5 E-09	1.5 E-05
FDP Dissolution Process (FAST stack)					
Off-site	1.0 E-02	1.2 E+00	2.5 E-02	2.3 E-03	1.2 E+00
CFA	2.0 E-03		5.0 E-03	4.5 E-04	7.4 E-03
TRA	8.2 E-04		2.0 E-03	1.8 E-04	3.0 E-03
ICPP fence	2.4 E-03		5.9 E-03	5.4 E-04	8.9 E-03
FDP Decontamination with Shutdown					
Off-site	1.3 E-06	1.2 E-04	7.3 E-07	9.0 E-10	1.2 E-04
CFA	2.6 E-07		1.4 E-07	1.8 E-10	4.0 E-07
TRA	1.0 E-07		5.8 E-08	7.2 E-11	1.6 E-07
ICPP fence	3.1 E-07		1.7 E-07	2.1 E-10	4.8 E-07

be calculated from the data included in table 4, using an appropriate correction for the number of days of operation and the processes in operation. This allows a prediction to be made of the total releases that might occur from the operation of any single process or a combination of several processes during a given year.

There are 10 operational conditions that affect the emissions from the Main Stack, CPP-708. These include operation of second and third cycle, denitrator, FDP [concurrent with operation of the Rare Gas Plant (RGP)], co-processing, E-cell zirconium dissolution, aluminum dissolution, electrolytic dissolution, Rover dissolution, NWCF operation (NWCF process off-gas), and emissions that occur during shutdown and decontamination efforts in the system.

There are two conditions that affect the releases from the FAST stack. These are the FDP process when the RGP is not in operation and decontamination efforts with concurrent process shutdown. Of these operations, only the second and third cycle, the denitrator, the NWCF, and D&D are projected to run in the future.

In addition to the data reported in the tables, an analysis was done based upon projected fuel processing rates in the year 2002. This analysis indicated that doses at the site boundary would approach or exceed current guidelines and should be considered if a decision is made to resume fuel processing in the future. A significant fraction of this dose was attributable to ingestion of Te-125m, which is a daughter product of Sb-125. As antimony/tellurium accounted for 80 to 90% of the calculated dose in the year 2002, consideration of a 90% efficiency for silica gel adsorbers reduces the calculated dose to a value well within current standards. The release of antimony is only a potential problem from fuel processing. There are no plans to resume fuel processing in the foreseeable future.

In addition to the calculations reported above, analyses have been completed to determine release limits and set control settings for normal operational conditions. Specifications and standards for releases from the FAST and Main stacks are based upon these calculations.

There is a three-level tier of controls set by technical specifications, technical standards, technical requirements, and DOE orders. The lower control level is set and controlled by the radiation monitors and the associated LCSs. This setting is established at the lower end of instrument sensitivity and can be considered an ALARA setting. Exceeding of this setting does not cause the exceeding of any DOE order or other regulation. At the second tier, the LCO control is below the maximum dose allowed per DOE Order 5400.5 (10 mrem/y) for normal operations. This release limit is sufficiently conservative to allow for multiple airborne releases without exceeding the DOE Order 5400.5 limit. The third level, which comprises SL controls, is not imposed for airborne releases. Regulatory requirements imposed by other criteria mandate cessation of operations at the LCO level. These limits are verified by radioanalysis of effluent samples and confirmed by environmental monitoring and sampling programs. Environmental monitoring and sampling are conducted by the DOE field office for the INEL.

Calculations done previously in support of technical specifications have been re-evaluated to determine whether the limits established by virtue of these analyses are still valid for the current objectives described in the foregoing paragraph. Due to the nature of the processes exhausted and to the change in mission, the Main Stack releases contribute more than 98% of the radioactive effluent from all ICPP release points. Controlling this ARP to a low rate of emission and a conservative total emission allows sufficient latitude for other releases that might occur from other operations.

An initial first determination was made to evaluate what total curie release from each of the two stacks would produce an TEDE of 1 mrem over any consecutive 12-month period. The purpose for this calculation was to establish a daily limit. These calculations were more conservative than those from prior analyses primarily due to ingestion factors. The differences result from differences in the effective stack height, different nuclide term, and the effect of analyzing acute releases using 95% meteorology. Actual releases from the FAST stack will be several orders of magnitude below this value due to the cessation of fuel processing. For example, a significant fraction of FDP releases can be attributed to Sb-125. This radionuclide will not be released during D&D operations.

The results from this evaluation were analyzed to determine what instrument setting would be required to alert personnel to that rate of release (28 Ci/y for the Main Stack and 16 Ci/y for the FAST stack) on a daily basis. For the FAST stack, the setting would be approximately 15,000 counts per minute (cpm). For the Main Stack (Train 1 and Train 2 monitors), this setting would be slightly less than 200 counts per second (cps).

It has been recommended[48] that the limit for the Train 1 and Train 2 monitors be set at 200 cps. This setting provides an adequate margin between the setting and potential false alarms. The 200 cps setting will alert personnel to a rate of release that, should it occur continuously over a 12-month period, would cause a TEDE of 0.13 mrem at the site boundary. To conform to this analysis, ***the LCS for the Train 1 and Train 2 monitors is 200 cps; and for the FAST monitor, the LCS is 15,000 cpm.***

Calculations used to establish these settings are included below:

A = gross gamma activity released from the stack since the last filter change

E = detector efficiency (counts/disintegration)

F = filter efficiency

R = ratio of the stack flow to monitor flow

Cps or cpm = cps or cpm as measured by the stack monitor

3.7 E+10 disintegrations/second per Ci

2.22 E+12 disintegrations/minute per Ci

$$\frac{(3.7E+10) \cdot A \cdot E \cdot F}{R} = cps$$

$$\frac{(2.22E+12) \cdot A \cdot E \cdot F}{R} = cpm$$

Train 1 and Train 2 Main Stack monitors:

A = 4.0 E-04 Curies

E = 0.118

F = .90

R = 8.0 E+03

LCS = 200 cps = Approximately 10% of cps

LCS conservatively controlled TEDE to approximately 0.13 mrem/y

FAST stack monitor:

A = 1.87 E-3 curies
E = .09
F = .90
R = 2.27 E+4
LCS = 15,000 cpm
LCS controlled TEDE approximately 1 mrem/y

The LCS controls the environmental releases within the DOE limit for the ICPP. ***Off-normal operations, unusual occurrences, and emergency situations are not a part of normal operations and may (or may not) cause the limits of DOE Order 5400.5 to be exceeded. Regardless of the magnitude of an airborne release resulting from an upset condition or an accident, the release is not considered as part of the ICPP normal operational emissions, but is treated as an accident.***

The Main Stack is the major contributor to ICPP airborne releases. Other release points (FAST, RAL, NWCF ventilation, Irradiated Fuel Storage Facility, etc.) are incrementally insignificant contributors to the ICPP airborne effluent profile. FAST was a major contributor prior to the ICPP mission change. Normal releases from the FAST facility will, with the possible exception of some D&D activities, be comparable to those from CPP-603. CPP-603 is the current fuel storage area. Releases from CPP-603 are sufficiently low that monitoring is not required. Monitoring will continue at the FAST stack, but sample filters are removed for analysis monthly. Sample filter analysis for the FAST stack is not a technical-specification-level requirement.

All radioactive sources are included in a cumulative running total for all ICPP emissions. The SLs, LCOs, and LCSs are set in a conservative enough fashion so that these small and incremental increases will not cause from normal operations the exceeding of DOE Order 5400.5. While the LCS is set to control normal plant operations within the limits of DOE Order 5400.5, this setting has been conservatively determined. The conservatism will allow for releases beyond the setting without necessarily exceeding the DOE Order 5400.5 limit of 10 mrem/y. These abnormal releases will not cause the dose at the nearest site boundary to be greater than that allowed for normal operations within these regulations. In other words, an unusual occurrence can occur, and operation of the ICPP facilities can continue in a normal, continuous fashion and still not exceed the airborne release standard should the decision to continue operations be made. The intent of these apparently conservative controls is to provide an adequate safety margin to maintain environmental emissions at an ALARA level. At the same time, these conservative controls ensure that normal operations do not exceed the limits set in DOE Order 5400.5.

Nonparticulate releases (which may vary according to operation) are normally measured and analyzed to determine their incremental impacts on the effluent profile. Control of these effluent and other ICPP release points is accomplished procedurally by requiring a running 12-month summation of all emissions (both particulate and nonparticulate) from all release points. This running total is required by the Federal Register of December 15, 1989, page 51657. Item 2 of that document is titled "Format of Standards," and the last paragraph of item 2 requires the running, cumulative total. Again, the conservative nature of the particulate control requirements allows for these incremental increases in TEDE during normal operation.

An extreme value analysis (EVA)[49] was performed to statistically determine the return rate for a release from an ICPP stack that would exceed the LCS. The EVA return rate for all ICPP sources is once every 3 years. This data was compiled from a time period when fuel dissolution was part of the process and the significant contributor to releases. One abnormal release of this nature per year would not cause the dose from normal operations to be exceeded. This dose, however, would not be charged to normal operations. The EVA did not include contributory factors from nonparticulate releases.

The EVA had several conservatisms built into the study. These conservatisms were made necessary due to anomalies in the data. These anomalies are detailed in the reference. Still, the return rate of 3 years for the occurrence is an acceptable number for the following reasons:

1) The basis for the specifications presumes worst-case meteorology.

2) An actual release will be evaluated based upon realtime meteorology.

3) A number of occurrences such as these would have to happen to begin to approach the 10 mrem/y standard of DOE Order 5400.5.

4) The EVA was based upon data that included fuel processing campaigns. Fuel processing is not included in the future mission of the ICPP.

With the change in mission at the ICPP, the radioactive constituent of the ICPP effluent will be considerably reduced. The actual doses at the site boundary from processes located at CPP-601 will be similar to the doses calculated and reported in table 4 for D&D in that facility (3.1 E-3 mrem/12-month period of continuous D&D). For FAST, the dose would be 4.8 E-7.

After the completion of decontamination in the fuel processing facilities, the NWCF POG, which is released from the Main Stack, is the major contributor to future ICPP airborne radioactive effluent. As reported in table 4, the NWCF POG will, in a 12-month period of continuous operation, contribute a 2.60 E-4 mrem dose at the site boundary.

9. SAFETY ANALYSIS

This section discusses the abnormal occurrences and accidents that could occur in the ventilation and off-gas systems. These systems, by themselves, are virtually passive. They do not generate hazardous, toxic, or radioactive materials. The design objective of these systems is to concentrate and confine any hazardous materials in the effluent, and to monitor, collect, and record the materials that are generated in other processes and potentially released to the environment. The systems are, however, sensitive to operational upsets and accidents that occur in the other processes or areas that they service. Assaults from these other systems can result in failure of the design objectives for the effluent treatment systems.

For the purposes of this document, accidents are those events that jeopardize the public health and safety beyond the INEL boundary or cause significant effects within the boundary. Such significant effects include excessive radiation dose (site boundary doses beyond the limit of DOE Order 5400.5 for the airborne pathway and on-site doses beyond the limits of DOE/EH-0256T), hazardous material exposure to on-site personnel (resulting in fatalities, total disabilities, or permanent disabilities), unacceptable property damage, or unacceptable facility downtime.

PAOs are events used in safety analysis in order to assess the defense-in-depth of controls and potential consequences. PAOs are those events not normally desired during operation that have effects less serious than accidents but may cause losses above those normally expected. PAOs occur more often than accidents and are controlled by procedures and contingency actions. Safety analysis identifies these potential occurrences to ensure that they are controlled to an acceptable level.

An additional category of accidents and occurrences involves events common throughout industry. These would involve mechanical failures, trips, falls, traffic accidents, and other events that are not unique to the facility described in the analysis. Limiting these occurrences to commonly accepted industrial frequencies or better is accomplished by ensuring that high quality equipment is initially purchased and properly maintained and that personnel are trained in the prevention of these types of accidents. Federal and state regulations and requirements mandate occupational safety requirements, and these requirements are implemented through operating procedures, training, and surveillance.

A generalized set of accidents can serve as an initial "cut set" to evaluate further where the ICPP is in its capability to accomplish its combined mission to confine, contain, and record environmental releases of radioactive material. An evaluation of these cut sets yields two conditions in which filtering or monitoring capabilities are compromised or lost when the event occurs. These scenarios are possible due to lack of hardness to withstand natural phenomena and inadequate protection of equipment intended to clean the effluent stream prior to release.

9.1 GENERAL CONSIDERATIONS

The level of concern for monitoring systems is, as mentioned before, a graded approach. These levels are determined by safety analysis with safety class criteria and redundancy requirements for lower grades described in DOE Order 6430.1A. If the safety class criteria are met in the analysis, then the monitoring systems must function through the DBA. The order further states that one barrier (primary, secondary, or tertiary) must remain functional through the DBA to contain the hazardous material. None of the ventilation, process, monitoring, or release points at the ICPP complies with all of these requirements. A DBA could, conceivably, compromise both the primary and secondary containment. There are areas (the duct from CPP-601 to CPP-756) where a failure due to an earthquake would cause the secondary confinement to exhaust directly to the environment. These secondary barriers are, however, normally not contaminated to a level that could cause an exceedance of restrictions imposed against the release of radioactive materials. A simultaneous failure in the primary confinement would violate all three barriers.

An earthquake with a horizontal ground acceleration greater than 0.12 g could cause failure of the Main Stack. Accident evaluation using instruments and dosimeters located at various places around the INEL could be used to determine the magnitude of the release. The loss of sample collection is discussed further in subsection 9.2.6.

Further, should the stack fall upon buildings in which primary confinement is required, a release could occur from these areas that would violate all three barriers and not be monitored. Post accident evaluation could, however, determine the magnitude of the release.

The other accident of concern involves fires. A fire does not have to occur in the ventilation system or even a cell served by the ventilation system to cause failure of the system. A fire in the laboratory areas of CPP-602 or in the operating or access corridors would likely be fought with water. There are no devices in place in the ventilation system to eliminate the moisture from the effluent stream. The increased water loading in the effluent could cause the filters to fail. Also, products from combustion and smoke that reached the final HEPA filters could cause plugging and filter failure. Smaller particles and particles of smoke would pass through the prefilter and cause plugging and failure of the final HEPA filters.

Equipment that was installed to provide compliance with older criteria may be deficient when evaluated against today's criteria. Because these systems are responsible for the treatment and monitoring of effluent, an accident in the systems will usually have a small or unmeasurable effect upon personnel or the environment. Radiation and contamination controls on the various components of the ventilation and off-gas systems preclude an environmental release that, by itself, would cause an unacceptable dose. An exception to this could occur when simultaneous accidents occur that cause failures in both the primary confinement and the ventilation filtering equipment. Another exception is when the filters are involved in a fire. The filters would have to ignite to release the total loading contained on them. Failure of the filters from wetting will, for example, cause the filtration function to be compromised but will not cause the filters to release their entrained activity to the environment. Any filter that could contribute to a release failure would result in the immediate cessation of operations.

All process operations at the ICPP are considered moderate or low hazard operations as defined in UCRL-15910.[12] Low hazard use facilities should be allowed relatively minor structural damage in the event of natural phenomena hazards. This is damage that results in minimal interruption to facility operations and that can be easily and readily repaired following the event. A reasonable performance goal is judged to be an annual probability of exceedance of between E-3 and E-4 of structure/equipment damage, with the facility being able to function with minimal interruptions.

The performance goal for moderate hazard use facilities is to limit facility damage so that hazardous materials can be controlled and confined, occupants are protected, and functioning of the facility is not interrupted. The design is such that confinement of hazardous materials is maintained. The annual probability of exceedance for moderate hazard facilities is E-4.

Elements of the off-gas system that might be affected by the maximum flood are the prefilter (CPP-756) for the ventilation APS and the lower level of the APS building (CPP-649) and the basement areas of CPP-604. The main floors of CPP-604, CPP-605, CPP-649, and the stack monitoring building (CPP-792) would also be subject to flooding by the maximum flood. With these systems disabled, or filled with flood-waters, the ventilation and POG systems would be out of service. Other elements are above the maximum height predicted for the flood crest.

The prefilter, when installed, was sealed to prevent the inleakage of water, and CPP-649 was designed to be watertight belowgrade with a design life of 20 years. There is no practical way to ensure that these structures are still in a watertight condition though, of course, a major flood crest would flow through the doors into CPP-649. The prefilter is provided with a steam jet to transfer any liquids to the PEW evaporator feed collection system for processing.

Most elements of the heating and ventilating (H&V) and POG systems are designed according to UBC requirements of the time. The structures and components, by themselves, would not be a source for sufficient material to exceed the guidelines for low to moderate facilities. This is sufficient to provide compliance with UCRL-15910, but does not ensure their availability during all accident situations. Because there was no additional design criteria, the failure of these components is an evaluation basis accident. There are no design basis accidents, and the exact point at which these structures might fail is not known. The APS ventilation duct from CPP-601 to CPP-756, which is supported aboveground, might not survive the impact of a windborne missile. This section of the ducting is upstream of the filtration systems. Negative pressure inside the duct would have to be compromised before the effluent could be released into the environment. The duct has never been structurally evaluated to determine the extent of damage required to compromise its ability to maintain confinement. This system, however, carries ventilation air only, and the release of radioactive material in this event would be minimal, providing the integrity of the primary confinement had not been compromised. As reported earlier, normal operational effluent does not exceed off-site dose criteria even lacking filtration and other mitigating effects. The interior of the duct is contaminated and, should the duct totally collapse, localized contamination could be released causing hazards to personnel within the ICPP confines.

A current design, providing resistance to the appropriate seismic events, would require that all safety class elements of the H&V and off-gas systems will survive the DBE for the ICPP. Requirements are based upon the ability of the facility to maintain one level of confinement (primary, secondary, or tertiary), given the effects of the DBE.

Aboveground ventilation ducts (an element of the secondary confinement), including those from LET&D, CPP-604, and the ventilation duct from CPP-601 to CPP-756, could fail in an earthquake or other accident. Failure of these systems is an evaluation basis accident. There was no specific accident against which the design was compared. The design of the duct is UBC only. It is also subject to failure from vehicular accidents and other external challenges. The primary confinement would, however, survive this event, unless building failures ruptured vessels and process lines for this confinement system. Without further evaluation, the seismic resistance of the primary confinement cannot be absolutely guaranteed. An earthquake could compromise the primary confinement and the secondary confinement in a single failure event. Failure of the primary confinement is a design basis accident. Failures of the outside ducting would leave an open route to the environment. However, rather than upgrading older facilities to comply with current criteria, UCRL-15910 allows for a change in usage of the facility and a reclassification of hazard category and seismic requirements. The change in mission significantly reduces the consequences of a simultaneous failure in the primary and secondary confinement systems because the systems, with the exception of the NWCF, no longer contain large amounts of process product and waste materials. Outside ducting for the NWCF is downstream from initial filtration equipment, and failure of this ducting would not compromise the confinement barriers. As a result of the mission change and the eventual D&D of reprocessing areas, subsequent environmental release that would exceed DOE limits as specified in DOE Order 5400.5 is highly unlikely.

CPP-756 and CPP-649 were designed to withstand a seismic event of 0.33 g horizontal acceleration, using the analytical techniques at that time (current analysis requires the use of additional force vectors). These buildings will probably survive the DBE of concern for moderate hazard facilities, using current analytical techniques. All other systems within the buildings, i.e., blowers, ducting, filter housings, etc., were designed to UBC Zone 3 standards. The magnitude of the earthquake these structures will survive is not known. The Main Stack was evaluated in 1983[14] and was determined to be able to withstand the then OBE (0.12 g horizontal motion) after the addition of another sheath and liner. Because the upstream facilities were designed to survive a 0.33-g earthquake, the equipment inside these facilities may survive a moderate earthquake. This cannot be determined without further analysis. If the equipment will survive the earthquake, failure of the Main Stack would not compromise the integrity of the filtration equipment unless the stack were to fall upon the buildings where the equipment is housed.

Monitoring equipment supplied at the stack would, however, be destroyed upon stack collapse. It should be remembered that failure of individual components in these systems does not compromise all the barriers designed to provide multiple levels of confinement and, failure of an entire barrier does not cause a release in excess of current guidelines.

One evaluated condition was the current condition of the CPP-756 prefilter vault and filter beds. It essentially involved the removal or diminished operability of some equipment for which credit was taken in the original analysis. The equipment removed from service never operated properly. An accidental activation of the fire suppression systems would likely have destroyed the downstream HEPA filters.

ANSI standards recommend cooling devices and water eliminating equipment upstream from the filters. Fire screens are also recommended to remove larger combustion products and inhibit flame spread. The POG side of the APS is near conformance with the intent of the guides. Condensers can, when operating, protect the filters by cooling hot gases resulting from the fire. Mist eliminators and superheaters protect the prefilters and final filters from moisture damage from fires at the NWCF and other upstream areas. VOG, DOG, and POG are vessel off-gas systems. They are less at risk from fires than ventilation types of systems that service secondary confinement areas.

The probability for a serious fire ("serious" meaning one which compromises the final filtration system) in any ICPP facility is low (E-4/y or -5/y). This probability was calculated from fire histories within the DOE complex. Fires causing a breach of the final filters are infrequent, given the total combined years of DOE facility operation. The most serious fire, at Rocky Flats, caused a partial breach that did not compromise the entire filter media. Administrative controls limit flammable material accumulation in all areas. In addition, ignition sources are usually not readily available but can be introduced from welding and other maintenance activities. The ICPP does not have an extensive history of small fires that could indicate an increased risk from lack of adequate fire controls and employee awareness.

Fire and explosion accidents in the process cells at the ICPP are of a low probability. Components in the ventilation system are constructed of fireproof or fire resistant materials. CPP-756 was designed and built with smoke detectors in the plenum. They were originally classified as Group I instruments. However, due to the large airflow in the duct, smoke detectors available at the time were not adequate to detect a fire. The installed detectors do not work. Newer detectors are being evaluated. The water fog system and the temperature instrument (also originally a Group I instrument), used to automatically activate the spray (at 150°F), have been placed on manual. The temperature indicator is checked once each 12-hour shift. There is no alarm on the temperature indicator for the vault. The original purpose of the fog spray was to cool the ventilation gases and to wash out burning particles originating from an upstream fire.

The use of this system to extinguish a fire in the prefilters is questionable. It was believed that the backflushing feature available in the vault could extinguish a fire originating there. The smoke detectors were installed to detect a fire in the prefilter vault.

A current problem existing in the prefilter results from a larger source term available for release. The backflushing equipment was installed to allow the filter to be cleaned. Material in the filter (presumably calcine) cannot be dissolved or removed with water backflushing. A bypass damper was installed that would allow the filter to be isolated. The backflushing apparatus has been disconnected, and the bypass damper has been determined to be nonfunctional. Operation of the backflushing device without the ability to isolate the vault would likely cause the final 104 HEPA filters to fail from water loading. A sump and steam jet are provided for the vault. The sump alarm and controls are not conveniently located and are not connected to an automatic system such as the DCS. Detection of an unacceptable amount of water in the vault and its subsequent removal cannot be easily done.

Abnormal occurrences and accidents in the ventilation and off-gas systems are primarily of the "operational" type as defined earlier as those incidents occurring due to design deficiencies or administrative or operational errors. The nature of the off-gas filtration and sampling systems (the confinement, collection, and monitoring of airborne effluent) automatically limits the consequences of abnormal occurrences. The loss of one of these capabilities will not, by itself, result in a release of material beyond the regulatory limits. Some events may, however, initiate a release of material from the secondary confinement area into occupied areas. ***Occupied areas are monitored with instruments to detect an increase in radioactivity into these places. When this equipment alarms, personnel are instructed to take action that will limit their exposure to the materials and, consequently, reduce the dose resulting from that exposure.***

There are multiple levels of protection on radioactive effluent streams. This is commonly referred to as "defense in depth." ***Defense in depth is provided on all POG streams. At least two banks of HEPA filtration are provided in these systems. In systems where moisture entrainment is a potential problem, equipment is installed to remove the moisture. Monitoring equipment is provided with standby power*** that, while not ensuring an uninterruptible source, will limit the downtime due to a power loss to minimal periods of time. Failure of these systems does not cause an increase in dose to personnel or the public. Likewise, failures of equipment designed to monitor releases will not cause an individual to be subjected to an exposure resulting in a measurable dose. Following is a discussion of PAOs and accidents that are possible within the ventilation, POG, and monitoring systems.

9.2 POSTULATED ABNORMAL OCCURRENCES

Table 5 summarizes the abnormal occurrences postulated for the airborne waste management systems. This subsection presents events that could occur from malfunction of systems, operating conditions, and errors during operation. As mentioned, the consequences from these events generally have little impact upon the health or safety of either the public or the operating personnel. The greatest consequence is usually the temporary loss of monitoring capabilities, or in some cases, personnel exposure to small amounts of radioactive or potentially toxic materials.

Table 5. Abnormal Occurrences

PAO		Possible Causes	Possible Effects	Design	Administrative	Detection	Sev[a]	Prob[b]	Risk[c]
				Postulated Abnormal Occurrences (PAO)					
				Prevention, Control, or Mitigation					
1.	HEPA-filter failure	Moisture loading; high delta P across filter; acid deterioration; incorrect installation; operation of steam jets without condenser.	Single filter or single bank failures will not cause significant releases above normal operations. Some radioactivity on filter may be released. Total decontamination factor is compromised.	Multiple filter banks in series, moisture removal equipment on process off-gas (POG) systems, acid resistant HEPA filters; pressure differential indicator (PDI) instrumentation; distributed control system (DCS) readout on PDIs.	DOP checks on filters when installed; surveillance of PDI instruments; contamination limits for filters; procedures for steam jet ops.	Periodic DOP checks.	1	2	2
2.	NO_x exposure	Leak in off-gas system; personnel error during maintenance.	Personnel exposure to NO_x fumes, possible injury.	NO_x monitors in enclosed areas of atmospheric protection system (APS) system.	Maintenance not allowed, except under specific conditions; hazardous work permits required during maintenance.	NO_x monitor with warning light, odor, personnel surveillance.	1	2	2
3.	Loss of vacuum on POG	Blowers are switched; blowers fail; flow changes.	Pressurization of POG system and possible release of materials to ventilation system.	Two blowers available; standby power provided; POG located within filtered ventilation system to contain the release; instrumentation records to DCS, automatic bypass around blowers during power loss.	Manual activation if automatic functions fail.	Operator surveillance.	1	2	2

[a] SEV = Severity level is a subjective measure of radiological, personnel, public, or environmental effects, i.e., 0 = routinely accepted, 1 = low (no measurable consequence), 2 = moderate (causing injuries or deaths on-site or EDE >500 mrem), and 3 = high (causing deaths, permanent injuries to personnel or, an EDE >5000 mrem.) Abnormal occurrences do not cause measurable off-site consequences.

[b] PROB = Probability level, i.e., 0 = incredible (< E-6/y), 1 = extremely unlikely (< E-3/y), 2 = unlikely (< E-1/y), and 3 = anticipated (> E-1/y).

[c] Risk = Severity x probability, i.e., 1 or 2 = acceptable, 3 or 4 = marginal, and 6 or 9 = unacceptable.

Table 5. (Contd.) Abnormal Occurrences

Postulated Abnormal Occurrences (PAO)								
			Prevention, Control, or Mitigation					
PAO	Possible Causes	Possible Effects	Design	Administrative	Detection	Sev[a]	Prob[b]	Risk[c]
4. Total loss of power	Total loss of commercial power through two substations; failure of standby power.	Loss of all exhaust blowers. Total power failure would also cause failure of dissolver off-gas (DOG), POG, and vessel off-gas (VOG) systems. Vacuum and pressure differentials would be lost. Contamination could be released from process areas into occupied areas but without other mechanisms; environmental release would be minimal.	Nitrogen activated outlet dampers on ventilation APS. POG has automatic bypass. Main Stack may provide natural draft. With natural draft, effluent is still filtered. Pressure differentials are lost but design retains primary confinement.	Manually close ventilation supply dampers; manually open exhaust dampers; monitor for contamination; if necessary, evacuate personnel.	Observation uninterruptible power supply (UPS) alarms.	1	2	2

[a] SEV = Severity level is a subjective measure of radiological, personnel, public, or environmental effects, i.e., 0 = routinely accepted, 1 = low (no measurable consequence), 2 = moderate (causing injuries or deaths on-site or EDE >500 mrem), and 3 = high (causing deaths, permanent injuries to personnel or, an EDE >5000 mrem.) Abnormal occurrences do not cause measurable off-site consequences.

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Table 5. (Contd.) Abnormal Occurrences

Postulated Abnormal Occurrences (PAO)									
				Prevention, Control, or Mitigation					
PAO		Possible Causes	Possible Effects	Design	Administrative	Detection	Sev[a]	Prob[b]	Risk[c]
5.	Single blower failure on APS ventilation	Power problems through one substation; mechanical failure.	Reduced airflow through ventilation system; system may briefly pressurize until supply blower(s) is balanced with exhaust.	Automatic switching through other substation; standby power; one blower left in reserve.	Reserve blower is periodically operated; preventative maintenance (PM) on all blowers.	Observation alarm in CPP-604, CPP-601.	1	1	1
6.	Failure of stack monitor to collect a sample	Condensate freezes in sample line; failure of sample probes; failure of sample pumps; failure of sample blowers; failure of filter; natural phenomena.	Reduction of ability to characterize release. No increased probability of release. Major effect is compliance with monitoring requirements.	Heat traced lines; dual probes; multiple sample pumps; standby power supply.	Repair or replace equipment. PM program, critical components are Group I.	Observation of ratio on DCS.	0	3	0

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Table 5. (Contd.) Abnormal Occurrences

Postulated Abnormal Occurrences (PAO)									
			Prevention, Control, or Mitigation						
PAO		Possible Causes	Possible Effects	Design	Administrative	Detection	Sev[a]	Prob[b]	Risk[c]
7.	Failure of on-line radiation monitor	Failure of radiation instrument. Failure to collect a sample for reasons noted in PAO #6.	Inability to detect an abnormal release and take administrative action to mitigate the release. No impact unless abnormal release occurs. Impact is in failure to comply with DOE requirements for radiation monitoring.	Redundant systems; redundant radiation monitoring equipment.	Instruments and equipment are Group I.	Loss of signal alarm on DCS. Instruments alarm on DCS.	0	3	0
8.	High radiation on HEPA filter	Process upset; failure to monitor.	Increased radiation exposure to personnel.	Radiation monitors provide constant monitoring function for some filters.	Daily surveillance of monitors; periodic monitoring by HP.	Radiation alarms or surveillance.	1	2	2

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Table 5. (Contd.) Abnormal Occurrences

Postulated Abnormal Occurrences (PAO)								
			Prevention, Control, or Mitigation					
PAO	Possible Causes	Possible Effects	Design	Administrative	Detection	Sev[a]	Prob[b]	Risk[c]
9. Loss of normal power to CPP-604 ventilation system	Failure of commercial power.	Supply blower will shut down; exhaust blower (WL-210, -211, -212) on standby power. Exhaust tunnel pressure upset. CPP-604 ventilation supply dampers will fail closed. Evacuation may be required due to possible release of contamination into building.	At least one exhaust blower will remain on-line to prevent release from building.	Ensure operability of one final blower on standby power. Conduct contamination surveys.	Operator observation DCS alarm.	1	2	2
10. Loss of steam to continuous process modification (CPM) DOG	Loss of plant steam supply.	Steam heater WN-304 will fail; downstream filter (WN-167) may be wetted and fail; jets will not operate.	POG APS provides filtering downstream.	Reduce vacuum if filter is wet.	Operator observation.	0	2	0

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Table 5. (Contd.) Abnormal Occurrences

Postulated Abnormal Occurrences (PAO)								
			Prevention, Control, or Mitigation					
PAO	Possible Causes	Possible Effects	Design	Administrative	Detection	Sev[a]	Prob[b]	Risk[c]
11. Loss of normal power on POG APS	Loss of commercial power.	Blowers OGF-213, -214 will switch to standby power; electric super-heater (OGF-308) will fail.	Standby power; steam superheaters will continue to operate.	Ensure blower operation on standby power.	Operator observation DCS alarm.	0	3	0
12. Total loss of power on POG APS	Loss of commercial power; failure of standby power.	Possible pressurization of system.	Automatic blower bypass valve will mitigate pressurization and vent to stack.	Notify manager; initiate repair of standby power.	Operator observation DCS alarm.	0	2	0
13. Loss of steam on POG APS	Failure of plant steam supply.	Loss of steam superheater; loss of liquid transfer jet operability; possible loss of filter OGF-131.	None.	Shut down activities that can add water to effluent.	Operator observation.	0	2	0
14. Loss of instrument air to POG APS	Failure of plant air supply.	Inlet and outlet blower valves will close; bypass valve will open; air will vent to stack.	Automatic controls will bypass system to prevent pressurization.	Shut off exhaust blowers.	Operator observation.	0	3	0

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[c] Risk = Severity x probability, i.e., 1 or 2 = acceptable, 3 or 4 = marginal, and 6 or 9 = unacceptable.

Table 5. (Contd.) Abnormal Occurrences

Postulated Abnormal Occurrences (PAO)								
			Prevention, Control, or Mitigation					
PAO	Possible Causes	Possible Effects	Design	Administrative	Detection	Sev[a]	Prob[b]	Risk[c]
15. Loss of instrument air to ventilation APS	Failure of plant air supply.	Loss of damper control.	Inlet dampers fail open; outlet dampers remain functional with nitrogen backup.	Nitrogen supply is checked to ensure operability.	Operator observation.	0	3	0
16. Loss of normal power to VOG	Failure of commercial power supply.	Failure of blower WL-209; possible pressurization of VOG; failure of electric superheater OGF-308.	Standby power; steam jet can provide backup.	Blower must be manually started after failure.	Operator observation.	0	3	0
17. Loss of steam supply to VOG	Failure of plant steam supply.	Failure of steam superheaters, WL-305 and -106; loss of jets; possible wetting and failure of HEPA filters.	POG APS provides filtering downstream.	Terminate all operations that may add moisture to VOG, CPP-601, CPP-604, CPP-640, CPP-641, and tank farm, monitor filters.	Operator observation.	0	2	0
18. Loss of instrument air on VOG	Failure of plant air supply.	Increase in airflow.	Control valves are fail open to prevent pressurization.	Shut down blower WL-209.	Operator observation.	0	3	0
19. Loss of power to CPM DOG	Loss of power to CPP-604.	No standby power; loss of blower function.	Jet WN-550 can be used to provide vacuum. Condenser OGF-104 can be used to remove condensate.	Procedures define action.	Operator observation.	0	1	0

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b PROB = Probability level, i.e., 0 = incredible (< E-6/y), 1 = extremely unlikely (< E-3/y), 2 = unlikely (< E-1/y), and 3 = anticipated (> E-1/y).

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Table 5. (Contd.) Abnormal Occurrences

Postulated Abnormal Occurrences (PAO)								
			Prevention, Control, or Mitigation					
PAO	Possible Causes	Possible Effects	Design	Administrative	Detection	Sev[a]	Prob[b]	Risk[c]
20. Loss of instrument air to CPM DOG	Failure of instrument air supply system.	Loss of all instruments; loss of valve controls.	No instrument readings; valves will fail open or closed, as designed.	Procedures define the action.	Operator observation.	0	2	0

[a] SEV = Severity level is a subjective measure of radiological, personnel, public, or environmental effects, i.e., 0 = routinely accepted, 1 = low (no measurable consequence), 2 = moderate (causing injuries or deaths on-site or EDE >500 mrem), and 3 = high (causing deaths, permanent injuries to personnel or, an EDE >5000 mrem.) Abnormal occurrences do not cause measurable off-site consequences.

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[c] Risk = Severity x probability, i.e., 1 or 2 = acceptable, 3 or 4 = marginal, and 6 or 9 = unacceptable.

Using a list of possible failure modes and assuming the presence of toxic materials, each component of the atmospheric waste management system was analyzed to determine what the effects of power loss, air loss, steam loss, fires, and natural phenomena events would be upon the systems. If an event could cause the release of materials into the environment or into occupied areas, the severity of the release was evaluated.

With the exception of stack monitoring failures, those PAOs with no consequences are not discussed in the text. Sufficient data is available in the tables. Monitoring functions have a special category, as defined in DOE Order 6430.1A. Therefore, while failures of the equipment do not produce a consequence measurable in terms of health and safety impacts, they are given a special discussion as they relate to the reliability requirements of the DOE Order.

9.2.1 HEPA-Filter Failure

HEPA filters can fail for a variety of reasons. Moisture loading is a common failure mechanism at the ICPP. Any entrainment of water, dust, etc., on a filter can lead to a high-pressure differential across the filter. Maximum allowed HEPA pressure differentials at the ICPP are controlled procedurally. This differential, if suddenly achieved, can cause the filter to fail catastrophically. The final APS POG filters exceeded the maximum allowed pressure drop in December 1992, due to smoke particles generated in an electric superheater. The filters were changed before a catastrophic failure occurred. These filters had failed earlier catastrophically, possibly from the same reason, though moisture may have been an additional factor. As a result of these problems, the electric superheater, HE-OGF-308, was removed from service. The prefilter, F-OGF-131, was also removed from service. Gasketing materials used in the prefilter were the source of the material that was burned in the superheater. Removal of these pieces of equipment from service and the associated procedural changes was evaluated as a potential USQ.[50] Procedural changes to remove the equipment from service and under what conditions are described in the USQ evaluation. Removal was determined to be within the safety envelope described in the currently approved authorization basis for the proposed operating mode. To maintain an equivalent level of multiple stages of testable HEPA filtration, alternatives have been explored. These alternatives include adding in-place ports to other filters that were non-testable, or repairing or replacing the F-OGF-131 system to correct deficiencies. It was determined to add ports to the VOG filter and to replace F-OGF-131 and F-OGF-100, -101, and -102 with an improved filter system. The ports have been added, and the additional upgrades have been completed. These modifications provide two testable stages of HEPA filtration in the POG side of the APS.

In prior analyses, credit has been taken for the ability of a PDI to detect a catastrophic breach in a filter. Credit was taken for this for both HEPA filters installed to prevent releases and HEPA filters used to collect samples from the effluent. Operational history has shown that PDIs will provide traceability for gradual buildup of particulate on the filter media. For sudden accumulations that result in catastrophic failures, the PDI will detect a spike in the pressure, after which the instrument returns to a normal operating range. Unless an operator witnesses this spike event, the failure will not be detected. Some HEPA filter PDI instrumentation is not alarmed and is not located in normally occupied areas. Because of undetected breaches of the POG APS filters (F-OGF-100, -101, and -102), the PDI was alarmed on the DCS. The replacement upgrades to these filter systems have retained this capability.

Due to the unreliability of detection of the catastrophic failure, both for effluent sampling and HEPA filtration systems, credit is not taken for these instruments. Pressure differential instruments in the APS ventilation and POG systems (CPP-604, CPP-649, and CPP-605) and in the stack monitor trains are not considered Group I instruments. Group I instruments serve to ensure that barriers against accidents are maintained and credit is taken for their reliability to detect, prevent, or mitigate an accident situation. These PDIs have been placed on the DCS system to allow detection of spikes that can be an indication of filter failure. ***Credit is taken for filter reliability, based upon the periodic in-place testing of the filters and the fact that multiple***

stages of filtration are used. Failure of individual filters will normally have no significant consequence when multiple stages of filtration are in place. An undetected failure of individual filters or filter banks on a realtime basis is an assumed risk of operation with a relatively high probability but with low consequences. Filter failures have to occur with other confinement failures and in multiple filter banks to cause measurable off-site consequences.

Reliance upon detection of the event for the worst possible occurrences is given by the stack monitors that sample and monitor releases when they occur. These instruments are Group I. Even with a PDI not considered to be Group I for a stack filter, redundancy on the realtime monitoring function provides a high level of confidence that releases will be detected and mitigation can proceed in a timely fashion.

This failure of a single filter (or several filters simultaneously) will not, by itself, cause an unacceptable exposure to radionuclides within the plant or at the site boundary. ***The allowed radiation level for filters is controlled and monitored to ensure that any activity released from filter failure is routinely acceptable.***

At the ICPP, the following features and procedures are used to reduce the probability and consequences of filter failures.

1) ***HEPA filters are arranged in serial or parallel multiple banks.*** For example, the final ventilation APS filters are arranged in 26 parallel caissons; each caisson can be isolated. A filter failing in a single caisson or several caissons at one time can be bypassed, and the filtering capability will not be compromised. Two serial stages are provided on POG systems that, due to the nature of the process they filter, are more susceptible to failure. If failures occur, this redundancy helps to ensure that additional intact HEPA filters are present downstream from the failed filter.

2) ***Some airborne effluent streams, where required, have additional equipment installed upstream from the filters to remove moisture and heat the effluent above the dewpoint.*** Requirements for the operation of this equipment are mandated procedurally.

3) ***HEPA filters, when possible, are tested in-place when installed and at least annually thereafter.*** Pressure differential instrumentation may provide for verification between in-place checks.

4) ***Some filters, where required, are monitored for radiation buildup. Limits are established in specifications or standards and implemented procedurally.*** This monitoring is done remotely using radiation area monitors (RAMs) or may be done using portable instruments.

9.2.2 NO_x Exposure

The POG from the NWCF contains NO_x when the calciner is in operation. In addition, pressurized bottles of NO_x are kept in CPP-692 for use as calibration checks for the monitor. Personnel can be exposed to this gas if leaks occur in the off-gas system, if maintenance activities are allowed on the POG system while the NWCF is operating, or if major leaks occur during maintenance of the NO_x calibration or monitoring equipment. Exposure to NO_x could result in a lost time injury. A more serious exposure is discussed in a following section as an accident. The following features reduce the probability of this exposure:

1) ***Ambient air NO_x monitors are installed in areas where personnel exposures might occur.***

2) ***Maintenance of NO_x bearing POG systems is restricted during operation of the NWCF.***

3) ***Hazardous work permits are required to work on the NO_x monitoring/sampling system.***

9.2.3 Loss of Vacuum on Process APS

The POG side of the APS system could be pressurized if the vacuum is lost, which provides a negative gradient between the ventilation system and the POG. If there is a simultaneous failure of the primary confinement, a release of the POG effluent into the ventilation system is possible. ***The ventilation systems are provided with HEPA filtration so any release from the primary into the secondary system will be filtered before it is released to the environment.*** Pressurization could occur from a sudden change in the flow of the POG, as could occur from a blower failure or when blowers are switched.

The following features and controls limit the probability and consequences from this occurrence.

1) ***Blowers are provided with standby power. A short pressurization may occur during switching.***

2) ***If there is a total power loss, automatic dampers will cause the POG to bypass the APS blowers. This provides a reduction in pressure differential through the POG system and allows natural stack draft to maintain the gradient between the ventilation system and the POG.***

9.2.4 Total Loss of Electrical Power

A total loss of electrical power would result in the loss of all ventilation and off-gas exhaust blowers. All gradients between the systems (DOG, VOG, POG, and ventilation systems) would be lost. This could cause a release of radioactive materials into the plant and possibly into occupied areas. Total power failures have occurred before at the ICPP without causing excessive release of contamination from the process areas. The consequences of such a release could be mitigated by personnel evacuation, if necessary. A release to the environment would be unlikely and, at most, would not cause any of the guidelines of DOE Order 5400.5 to be exceeded.

The following features and controls limit the consequences of this event.

1) ***Disabled POG APS blowers are automatically bypassed, and stack provides natural draft.***

2) ***Radiological control technicians (RCTs) provide monitoring during the period in which power is lost.***

3) ***In the event of contamination release, personnel can be evacuated.***

9.2.5 Ventilation APS Single Blower Failure

Failure of a single APS blower is bounded by subsection 9.2.4. The same mitigating features apply. The possibility for contamination release is considerably less. Pressurization of system, if it occurs, would be a transient event while standby blower is brought on-line and the system is balanced.

9.2.6 Failure of Stack Monitor to Collect a Sample

The stack monitor could fail for a variety of reasons. Due to the perceived importance of sampling and providing realtime radiation measurements of the effluent, after installation of the Train 1 monitor, ***all components of the particulate monitor and sampling equipment are redundant for main effluent release points at the ICPP. Further, standby power is provided to maintain sample pump operability.*** This criterion is placed upon stacks that could, under upset process conditions, release radionuclides to the environment that could cause the DOE Order 5400.5 dose limitations to be exceeded. The function, survivability, etc., of monitors is that they should provide uninterrupted service where the limits of DOE Order 5400.5 could be exceeded during any accident condition.

Still, for safety analysis purposes, the failure of any monitor does not create a safety hazard. The monitor does not prevent the accident. The consequences of a monitor failure from a health and safety viewpoint are zero, unless a concurrent process failure causes a release. In release situations, the monitor can provide data relating to the proper response to the accident. This can reduce the consequences of the event by accelerating the response to the event. A monitor failure is considered, by itself, to have no consequence. The consequence of a failure, which is simultaneous with a processing accident, is driven by the magnitude of the accident. For this reason, monitoring stations are analyzed according to the possible accidents that they are required to monitor. With the increasing severity of the accident, monitor reliability is given more importance. The highest level of concern for monitors is "safety class" as defined by DOE Order 6430.1A. If the accident can cause the dose in the public domain to exceed the limits for normal operation, as defined in DOE Order 5400.5, the monitor is a safety class monitor. The probability levels for these failures (on the PAO table) is given a classification of 3, which means it is anticipated. This is a generally accepted criterion for instrumentation. For systems designed to safety class criteria, the probability for failure of a totally redundant, seismically certified monitor with a safety class power supply system would be between 0 and 1, incredible to extremely unlikely. However, while the Main Stack is currently considered to be safety class, it was not designed or installed to that criterion. Each upgrade completed for the stack and the associated monitoring equipment has brought the entire system closer to that criterion through the last several years of Main Stack upgrade projects. The stack and monitor do not satisfy seismic criteria or safety class power supplies. The monitor does have a standby power supply, but it does not meet DOE Order 6430.1A criteria for safety class. The probability for complete failure of the stack and the monitoring functions in its current design is 2, unlikely.

For failures compromising one-half of the redundant system the probability for this failure in a safety class designed system is 2, unlikely.

The risks from these probabilities are difficult to evaluate in a traditional sense because the monitor does not prevent the accident; the monitor can only define the level of the accident and provide the data to determine the correct response. The criteria of DOE Order 6430.1A are the best determiners of the reliability for effluent monitors. These criteria remove the monitors from the realm of risk assessment by simply saying that the monitors must provide their functions through the DBA if the DBA can cause the dose criteria of DOE Order 5400.5 to be exceeded.

On the PAO table in this section, many items are given a consequence value of zero. This is true for failure of that item only. This failure, in conjunction with other failures in process systems, can change this value. The PSD postulates the worst possible accident scenario for ICPP processes. These accidents combined with other failures in the airborne waste management systems have determined the level of reliability required for monitoring stations. The Main Stack monitor and the NWCF monitor are the only monitors requiring safety class criteria. Other monitors (FAST, RAL) may require redundancy for operational reasons but are not safety class. These monitors are not currently redundant. A redundant monitor that is not equipped with a safety class power supply has a single train failure probability level of 3. A simultaneous failure in both trains has a probability level of 2. No effluent monitors at the ICPP are provided with safety class power supplies.

Section 4 of ANSI Standard N13.1-1969 establishes the principles to be used as guides if effective sampling is to be realized. The first principle is the requirement that the sample be representative.

Representative is defined in the standard as, "Faithfully showing the qualities and characteristics of the entire volume from which a sample is drawn." A sample must be representative of the bulk stream or volume from which it is taken. "Representative" embodies various qualities of the sample. These qualities include physical size (diameter), density, physical composition, and others such as the actual rate of sample withdrawal being equivalent to the total stack velocity, a condition known as isokineticity. These conditions may change during accidents and cause errors in the collection of a full range of particle sizes. This will not affect the ability to detect the accident but only to quantify it later.

To meet these standards requires a system engineered with all components designed to minimize the potential for errors. Sampling errors that can occur and what is done to reduce the errors are discussed below:

1) An error can occur when the sample is withdrawn from a location in the stack without sufficient distance downstream from flow transitions or flow changes. Five stack diameters is considered the minimum distance from such a perturbation in the stack flow. The standard states that 10 or more diameters is the preferable distance. This helps to ensure that adequate mixing of the sample has occurred prior to withdrawal. During some accidents, monitors designed for stack conditions during normal operations may not collect a representative sample. This will not affect detection of the accident. It may, however, affect the subsequent analyses performed to characterize the release.

   Providing a sufficient distance downstream for sample collection may also provide time for changes that can occur from chemical reactions between gases that can form particles. A factor that can easily be overlooked is that of changes in the quality of the particles and gases carried in the air stream as the air moves along the passage. Changes can occur from reactions between gases to form solid particles, particles may be wet or dry depending upon the temperature and moisture loading; they may agglomerate if concentrations are high enough. The most obvious solution is to provide a sampling location at a point as far downstream as possible. In the case of a stack or duct discharging to the atmosphere, the sampling station should be at or near the release point if these effects are anticipated. This is true in the case of antimony and ruthenium that are released from ICPP processes as volatile gases and later oxidized to a particle. If the sample is taken prior to the oxidative reaction, the volatile phase may be the only sample phase available. This volatile phase will pass through the sample filter, and the potential dose will be understated in any subsequent analysis. The collection point at the ICPP for the Main Stack is sufficiently downstream to maximize the ability to collect a representative sample. The same is true for other airborne effluent monitors (the NWCF and the RAL), even those not totally designed in compliance with the ANSI standard.

2) Sampling errors will occur if the sampling location does not provide an adequate number of sample withdrawal points and a good design of sample entry tubes. The standard provides the following criteria. The particle and gaseous composition is representative at the point in the cross section selected or enough points in the cross section are sampled simultaneously. The velocity and flow distribution should be known so that the rate of sampling can be chosen to provide near-isokinetic sampling for particles. The number of points depends upon the cross-sectional area of the stack. For a stack of 50 in. or larger, the minimum number of points is six. Stacks with several sample points and a potential for flow variability across the stack diameter should ideally maintain a different exit velocity for every withdrawal point. Exit velocities on the ICPP Main Stack monitor are controlled with eight withdrawal points and six thermal anemometers on each of two sample rakes. The sum of the thermal anemometers is used to automatically control the exit velocity for the sample rake.

3) An error can occur due to particle deposition in the sample line. This is more severe when the sample line has short radius tubing bends, long horizontal runs, or the sample line splits. For a sample tube that divides, two flowrates have to be maintained as isokinetic. The criteria for representative

sampling must be met for each sample line. When simultaneous samples are required for different purposes, the ANSI standard states that obtaining them is justifiable under the following conditions: (The example is given for a single sample that is required for three purposes and is, therefore, divided after its withdrawal from the stack.)

a) When an integrated sample is required to represent a fraction of the total material present during a 24-hour or longer period.

b) When a sample is taken for a continuous or intermittent radioactivity monitor.

c) When a sample is taken for measuring the instantaneous radioactive material passing through a duct or stack.

Where side streams are withdrawn at the Main Stack, the isokinetics of the sample are maintained for each stream. The NWCF ventilation sampling equipment does not maintain isokinetic conditions after the withdrawal of side-stream samples. The sample is isokinetic at the sampling location, however. A total isokinetic sample is, therefore, withdrawn, but at the point of sample separation, each sample stream may not be representative in terms of particle size distribution. Because the sample withdrawn is isokinetic, the error resulting from this condition is probably not great. As demonstrated in ANSI Standard N13.1-1969, relatively large errors in isokinetic sampling will cause relatively small errors in the sample itself. The sampling error is significantly reduced for particles of less than 5 μm average median aerodynamic diameter (AMAD). Particles within the range of those normally emitted after HEPA filtration tend to follow natural flow variations under the conditions present in the effluent during normal operations. Larger particles, which might be released during accident conditions or after a filter failure, may impact or deviate from the flow path, causing subsequent errors in characterization of the release.

4) Errors can occur due to an isokinetic sampling. Such a distortion can occur when the velocity of the sampled air entering the sample probe is significantly different from the velocity of the air in the stream sampled. When the air drawn through the sampler or collector in the stream is at a much lower velocity than the stream velocity (subisokinetic), larger particles are preferentially collected. When the air velocity through the sample probe and collector is greater than the stream velocity (superisokinetic), smaller particles are preferentially collected. Smaller particles, due to less kinetic energy, follow a flow path that is not laminar. Larger particles, possessing more kinetic energy, tend to follow a straight path. As the flow eddies around the sample probe, the larger particle, tending to follow a straight path, can be diverted from the path and collected in higher concentrations than would normally be the case. The degree to which this occurs is a function of the aerodynamic diameter of the particle, particle density, the size distribution in the total volume to be sampled, and the difference between the relative velocities of the isokinetic versus the anisokinetic velocities. Generally speaking, particles with an aerodynamic diameter of 5 microns or less follow the air stream, and an anisokinetic condition does not result in a significant sampling error. Subisokinetic sampling will usually result in an oversampling condition, whereas superisokinetic sampling will result in a reduced sample volume. ICPP effluent has passed through HEPA filtration prior to release. Particles passing through these multiple stages of filtration would normally be much less than 5 microns and would follow the air stream. A 30% anisokinetic condition will result in less than a 3% conservative error for the sample.

5) Moisture in the effluent could cause sampling errors through a variety of mechanisms. Excessive moisture can result in the sample filter becoming less porous and could cause the filter to tear. Moisture in this case causes two different results. The first is a distortion of the actual amount of material in the effluent due to changing filter porosities or a loss of sample due to a filter that tears. The second is when condensation inside of sample tubes results in wetted surfaces to which sample particles may adhere. Pockets of liquid in bends or along horizontal runs can act as scrubbers to actually remove the sample from the stream prior to collection on the filter media.

A release of ammonium nitrate from the ICPP Main Stack was initiated when material coating the stack was subjected to increased temperatures. This occurred during testing of a new process that injects relatively large amounts of steam into the stack effluent. The stack monitor consisted of an older system and a single sample train from a newer design built to conform to ANSI standards. The old monitor and the new monitor were operating simultaneously. The newer monitor detected a release, while the older monitor did not. The reasons for this discrepancy have not been fully determined. It is not unreasonable to assume that in the older monitor with fewer sample positions, and less consideration given to sample line runs and bends, a factor in the loss of sample possibly was condensation created by the steam from the new process. The condensation might have formed water traps, pockets, or increased moisture on the walls of the tubing. In horizontal sections, this would coat the tubing. In vertical runs, it could collect and pool in tubing bends. These effects could have caused a considerable sample loss and are a reasonable explanation for differing results from the two monitors. ***The heat trace on the new monitor sample lines is set above the stack temperature and is alarmed on the DCS.*** This trace helps to eliminate the formation of condensates within the sample lines.

While the consequences of monitor or sampling failure occurring simultaneously with process failures, which compromise the redundant barriers to an environmental release, cannot be accurately determined, they can be estimated. Backup programs exist that can characterize the magnitude of a release through nuclear accident dosimeters, environmental monitors positioned around the INEL, and data received from NOAA concerning current accident meteorological conditions. While this data would not be available simultaneously with the accident, it would be available within 12 to 24 hours. In the interim, Lockheed Martin Idaho Technologies Company (LMITCO) ICPP personnel will (and have in previous abnormal operating releases) take a conservative approach to the declaration of response level. The conservative approach taken is based upon the available information and ensures that the public protection is maximized. This action normally will require that the event be downgraded as more information is collected.

9.2.7 Failure of the On-Line Radiation Monitor

Failure of the on-line radiation monitor also normally would have a consequence of zero. The discussion in subsection 9.2.6 applies to this failure as well. The reliability of the monitor to respond to a release is dependent upon the potential magnitude of that release, and the safety class criteria are applied or not applied according to that process accident scenario. An additional factor to consider in the failure of the monitor is that operations personnel will not receive a timely notification that the DBA has caused a release. As is the case described in subsection 9.2.6, the consequences from the loss of this timely notification cannot be accurately evaluated, but could compromise management response to the accident and the ability to mitigate the consequences. ICPP management will respond in a conservative manner to any environmental release.

9.2.8 High Radiation on a HEPA Filter

High radiation fields from a HEPA filter could occur 1) as a result of a process upset that caused rapid contamination of the filter or 2) through operator error in not providing adequate surveillance of the filter, as required procedurally. The consequence of this event would be increased radiation exposure to personnel changing the filter.

9.2.9 Loss of Normal Power to CPP-604 Ventilation System

Failure of commercial power causes a loss of ventilation supply to CPP-604. The supply blower shuts down. Blowers WL-210, -211, and -212 supply the motive force for the CPP-604 exhaust. During loss of commercial power, one of these blowers remains on-line powered by standby power. In CPP-604, the ventilation supply dampers will fail in a closed position. Simultaneous failure of the exhaust fans can cause the possible pressurization of the exhaust vent tunnel that could cause the building to become contaminated. Procedures require building evacuation in the event of this occurrence.

9.3 ACCIDENTS

Accidents described for the airborne waste management systems are of two types. A set of accidents can occur from fires within the plant facility or within a filter bank, causing the subsequent failure of filtration and monitoring capabilities. These fires could be initiated in a variety of ways. Another set of accidents results from natural phenomena initiators. All accidents are summarized in table 6.

9.3.1 In-Plant Fire

A fire in a facility such as CPP-601, CPP-604, CPP-605, CPP-633, the LET&D, the NWCF, or the FAST facility would be fought using automatic and manual systems, most of which use water. With the ventilation system operating, water and products from combustion could possibly be entrained and carried out to the final filters. The CPP-756 prefilter was built with a water fog system to cool the gases and knock out burning particles before they reached the filters. This was automatically activated but has since been placed on manual activation. A significant particle loading could cause the final filters to fail. Further, incendiary

Table 6. Accident Scenarios

			Prevention, Control, or Mitigation					
Scenarios	Possible Causes	Possible Effects	Design	Administrative	Detection	Sev[a]	Prob[b]	Risk[c]
1. Plant fire	Welding, cutting, etc.; electrical; chemical; storage of flammable materials.	Failure of HEPA filters through particle and moisture loading; release of volatile hazardous materials, or environmental contamination.	Rapid fire suppression systems, some of which are not water flushes or sprays.	Work control (fire watches, hazardous work permits); local fire brigade; professional fire department within 5 km.	Alarms, visual.	1	2	2
2. Fire in CPP-756 and CPP-649 filter units	Upstream fire; combustible gases; chemical reactions.	Failure of filtration units; release of 100% of contamination from filters to the environment; failure of sampling system to quantify release.	Same as above to prevent upstream fires; no design elements to prevent or mitigate fires in filter media.	Same as above.	Visual, high Δp may be detected by operators.	2	1	2
3. Fire in CPP-756	Same as above.	Failure of CPP-756 filter; possible failure of CPP-649 ventilation HEPA filters due to increased pressure drop and filter rupture; release of contamination on CPP-756 filter to CPP-649. Release fraction of 100% of material on prefilter and 10% of material on final filters if CPP-649 filters fail and do not burn.	Same as above.	Same as above.	Visual.	2	1	2

[a] SEV = Severity level is a subjective measure of radiological, personnel, public, or environmental effects, i.e., 0 = routinely accepted, 1 = low (no off site consequence), 2 = moderate (causing injuries on or off site, off site EDE >500 mrem), and 3 = high (causing deaths on or off site, off site EDE >5000 mrem.

[b] PROB = Probability level, i.e., 0 = incredible (< E-6/y), 1 = extremely unlikely (< E-3/y), 2 = unlikely (< E-1/y), and 3 = anticipated (> E-1/y).

[c] Risk = Severity x probability, i.e., 1 or 2 = acceptable, 3 or 4 = marginal, and 6 or 9 = unacceptable.

Table 6. (Contd.) Accident Scenarios

			Prevention, Control, or Mitigation					
Scenarios	Possible Causes	Possible Effects	Design	Administrative	Detection	Sev[a]	Prob[b]	Risk[c]
4. Collapse of Main Stack (CPP-708)	Seismic event beyond stack design.	Failure of other safety class systems; loss of other structures; failure of high level liquid waste tanks; five or more deaths and/or serious injuries.	Design basis earthquake (DBE) is beyond design of stack.	Emergency procedures define level of response appropriate to damage and release.	Visual.	3	1	3
5. Cell ventilation duct rupture	Wind, seismic.	Localized release of contamination within confines of ICPP; possible serious injuries or death.	UBC Zone 2.	Emergency procedures define level of response appropriate to damage and release.	Visual.	2	1	2
6. Rupture of process off-gas (POG) line from NWCF to atmospheric protection system (APS)	Seismic.	Loss of final filtration steps.	UBC Zone 2; double-encased line.	Emergency procedures define level of response appropriate to damage and release.	Visual.	1	1	1
7. Fires in individual filter units	Welding, grinding.	Release of contamination from single filter unit.	No ignition source in individual filter units.	Work permits; fire watch; conduct of operations.	Visual.	1	1	1
8. NO_x exposure	Pressurized Leak in off-gas system, personnel error.	Personnel exposure to high concentrations of NO_x fumes resulting in death.	NO_x monitors in potential release areas.	Maintenance not allowed except under special conditions; work permits.	NO_x monitors; personnel surveillance.	2	1	2

[a] SEV = Severity level is a subjective measure of radiological, personnel, public, or environmental effects, i.e., 0 = routinely accepted, 1 = low (no off site consequence), 2 = moderate (causing injuries on or off site, off site EDE >500 mrem), and 3 = high (causing deaths on or off site, off site EDE >5000 mrem.

[b] PROB = Probability level, i.e., 0 = incredible (< E-6/y), 1 = extremely unlikely (< E-3/y), 2 = unlikely (< E-1/y), and 3 = anticipated (> E-1/y).

[c] Risk = Severity x probability, i.e., 1 or 2 = acceptable, 3 or 4 = marginal, and 6 or 9 = unacceptable.

particles and gases could initiate a secondary fire in the prefilter. Lacking the capability to isolate the vault under these conditions, the final 104 HEPA filters are at risk.

In POG systems, the potential for a fire that could compromise the filtering ability is reduced. These systems can receive hot gases from a plant fire only if a vessel or pipe ruptures. Fires within the POG systems could occur at a much lower probability. POG systems have a higher probability for explosions or rapid conflagrations rather than sustained fire scenarios. Then, downstream from these vessels are mist eliminators and condensers that, when operating, will cool the gas and provide protection for the final filter banks. Depending on where within the system the fire were to occur, various amounts of radioactive materials could be entrained in the gases. As long as the final filters were not breached, the radioactive release would be controlled to below current release limits. Without breach of the primary confinement, only small amounts of radioactive material would be involved in the fire.

9.3.1.1 Plant Fire Involving CPP-756 and CPP-649. The worst accident that could occur in the gaseous waste management systems is a fire that involves both the CPP-756 prefilter for the ventilation APS system and the subsequent involvement of the 104 final HEPA filters of the ventilation APS system in CPP-649. This would release the radioactive material entrained in the ventilation filters and release it from the Main Stack. The stack monitor filters would probably plug due to large particles. The accident would then be difficult to characterize after it occurred. Environmental samples could be used, however, to aid in the analysis. Characterization would depend (as it did to some degree in the Rocky Flats fire of 1969) upon samples taken from the facilities and collected in the environment.

Based upon radiation surveys of the CPP-756 prefilter vault, calculations have been completed to determine a conservative curie loading for this prefilter.

The modeling assumptions and the accident scenario for this accident are described below.

An upstream fire spreads through the ventilation system fed by the fire upstream (similar to, but slower than, a chimney fire). There is no routine inspection program for the ICPP ducts. A recent special survey indicated that the material in the duct (where sampled) would not, by itself, support a flame. It would, however, burn if supplied by heat from upstream sources. This is similar to the benelex situation in the Rocky Flats fire. If combustible dust and organic material are present in the ventilation system, the nature of this fire would be worse in that the heat and combustion products entering the prefilter vault would be increased. The fire could originate in a process area, a process corridor, an operating area, or any other area that is served by the ventilation system in CPP-601, CPP-602, CPP-604, CPP-640, CPP-627, and CPP-633. This fire initiates a secondary fire in the prefilter vault (CPP-756). Hot particles from the prefilter vault cause failure of CPP-649 final HEPA filters. The heat and gases from the fires, combined with the chimney effect produced by the system, could resuspend or volatilize contamination that was entrained on the prefilter media and the final HEPA filters, and release it up the 250-ft stack, CPP-708.

The CPP-756 prefilter is a deep-bed fiberglass prefilter that provides a roughing filter for the final HEPA filter stage in CPP-649. It has been in continuous use since 1977. Samples taken from ventilation ducting indicate that some combustible, organic materials are probably present on the filter. It is not known if the material in the filter will, by itself, support a flame. It should be similar to the material in the duct. Even so, the analysis assumes that the material is volatilized either through its ability to burn or due to heat generated upstream. Contamination present in the duct has not been quantified and is not included in the calculation. In addition, it is possible that some quantity of ammonium nitrate is present in the filter.

The prefilter is contained in an underground vault that is 40 x 90 x 14 ft high. It is constructed of reinforced concrete and divided into four bays. The bays are oriented in an east to west direction with flow entering from the west side. A plenum is provided, which distributes the flow evenly among the four bays. Each bay contains five layers of separately supported packed layers of Owens Corning fiberglass 115k. These fiberglass layers, starting at the bottom, are as follows: two 15-in. layers with a packed density of 0.7 $lb\text{-}ft^{-3}$, two 18-in. layers with a packed density of 1.5 $lb\text{-}ft^{-3}$, and a final layer of 18 in. with a packed density of 3.0 $lb\text{-}ft^{-3}$. The five individual layers are separated and supported by stainless steel screens. The screens are 0.162-in.-diameter stainless steel wires on 1-in. centers. The screens are mounted on carbon steel frames, 9 ft 3 in. long by 4 ft wide and supported by 2.5-in.-diameter schedule 40 carbon steel pipe spaced at 3-ft intervals. The screens are wired to the support pipes. The resultant frame is attached to the unistrut imbedded in the concrete walls; the void in the unistrut as well as other open areas is caulked with fiberglass to prevent bypassing of the filter media. Support of the screen to maintain the required compression of the fiberglass, as well as uniform thicknesses, is designed to withstand the following forces:

1) Operating pressure differentials of 15 in. of water across any one layer.

2) Short term saturated moisture loading during backflushing operations.

3) A shock impulse loading of 2 psig due to a postulated in-cell explosion (CPP-601) (1.5 psig overpressure plus 15 in. of water operating pressure drop).

The prefilter was originally designed and installed with a damper to isolate the filter for backflushing operations (to prevent wetting of downstream HEPAs). It was provided with a water backflushing capability to clean the filter media. Credit was taken for the backflushing equipment to be used in the event of a prefilter fire. A heat-activated water fog system was installed to cool the ventilation air entering the prefilter. This system was intended to be used to cool gases resulting from upstream fires and was automatically actuated at 150°F. Smoke detectors were installed in the inlet and outlet plenums. The smoke detectors do not function. The automatic feature of the fog spray has been disconnected, and the spray was placed on manual actuation. If required, this automatic feature could be reconnected. Use of the spray could, however, cause a failure of the final filters.

The vault has four radiological survey ports, which are 4-in. schedule 10 stainless steel pipes (wall thickness 0.12 in.), inserted through the filter media and sealed on the bottom. Surveys were done in December of 1976, January of 1977, and August of 1988. The radioactive loading indicated in the second survey (January 1977) is slightly lower than the one in 1988, indicating that 11 years of operation since then has not added considerably to the loading on the filter. Between the first and second survey, the WCF had an incident that released activity to the ventilation APS. Because the difference in that survey is not significantly different from the one in 1988, it may be reasonable to assume that most of the activity currently on the prefilter is from the WCF incident. Additional radiation surveys were taken in December of 1992.

Assumptions for the analysis include the following:

1) There are no mitigating features to prevent the fire.

2) The ventilation system operates through the accident period of 2 hours.

3) One hundred percent of the radioactive contaminants in the prefilters are released from the vault.

4) One hundred percent of the radioactive contaminants are released from the final HEPA filters.

5) Wind speed is 2 m/s, and the release occurs during Pasquill Class F, fumigation, conditions to model the on-site release and Pasquill Class D to model the dose at the site boundary. These conditions provide the most conservative results at each location.

The original SAR for the ventilation APS system presumed an isotopic mix for the prefilters and final filters based upon 90% of loading to be a result of CPP-601 processing (from coprocessing campaigns) and 10% of the mix to be from waste calcining activities. This source term was valid for calculations used in prior analyses. Because it is principally a result of fuel processing activities, this source term is not valid for use in the current analysis due to the evidence that most of the activity is from the WCF (an occurrence of January 1977.)

The event that caused the original release of material into the prefilter vault occurred in January 1977. The following is a nuclide mix determined from an average of four samples taken from WCF feed in December of 1976.[51]

Composition of Feed Solution to WCF During December 1976

Total Transuranics

TRU	mg/L
total Pu	2.18
total U	0.422
Mixed Fission Products (MFPs)	dis/s/ml
Tritium	3.01 E+4
Cs-137	3.46 E+7
Cs-134	1.39 E+6
Ce-144	3.49 E+5
Co-60	2.54 E+4
Sb-125	3.27 E+5
Ru-106	4.39 E+5
Sr-90	2.84 E+7
Eu-154	3.34 E+5
Eu-155	1.43 E+5

Using this data, the radiation technology personnel within the Safety and Health Directorate derived the following source term for material retained in the filter based upon radiation readings and calculations described below. An additional decay period of 17 years was applied (accounting for the period in which the material has been resident in the filter). According to these calculations, the total amount of activity in the prefilter is approximately 43 Ci.

CPP-756 Accident Source Term

Nuclide	Curie Loading
Ba-137m	9.85
Ce-144	4.14 E-8
Co-60	1.21 E-3
Cs-134	2.05 E-3
Cs-137	1.04 E+1
Eu-154	3.90 E-2
Eu-155	5.91 E-3
Fr-223	1.44 E-11
Pa-231	4.60 E-9
Pr-144	4.14 E-8
Pr-144m	5.92 E-10
total Pu	5.26 E-1
Rh-106	1.5 E-6
Ru-106	1.5 E-6
Sb-125	1.91 E-3
Sr-90	8.39
Te-125m	5.08 E-4
U-234	2.71 E-5
U-235	1.28 E-3
Y-90	8.39

As a first step in the analysis, new radiation readings were taken on March 18, 1993, from the prefilter vault. While readings were taken from four different locations in the vault, it was conservatively assumed that the reading was from a single location, centrally located, and that contamination was homogeneously distributed throughout the entire volume of the filter media.[52]

This central point reading was obtained by averaging the four locations at each measurement depth through the thickness of the filter. Readings were taken at 5, 10, 12, 14, 16, and 17 ft. The averaged dose at each level was (in mrem/h) 35, 136, 123, 200, 223, and 214.

The highest measured reading at the 17-ft foot level in the vault was 310 mrem/h. The highest reading from the 5-ft level was 30 mrem/h. These readings are consistent with those taken in years past and since the filter became contaminated due to a WCF filter failure. Using the WCF feed data from 1976 and an appropriate decay period, a calculation was performed that yielded the source term for the radiological constituents in the vault reported above.

Meteorological parameters were calculated for maximum consequence at each location using differing meteorological classes for each calculation. Using 95% meteorological accident conditions over a 24-hour period, the calculated total effective dose equivalents (TEDE) from the release of the material in the CPP-756 vault are as follow:[53]

Downwind Distance (m)	TEDE(rem)
100 (ICPP)	8.7E-1
2414 [Test Reactor Area (TRA)]	4.3E-2
4024 (CFA)	2.7E-2
14,000 (site boundary)	2.6E-1

The postulated accident scenario presumes that this fire propagates into the final bank of HEPA filters of which there are 104 arranged in a parallel configuration. Given a fire in the prefilter and the absence of equipment to prevent spreading of the fire, it is reasonable to assume that this fire could spread into the final bank. A probability of E-1/y is assumed for the simultaneous involvement of both filter banks given a fire in the prefilter (probability $\leq$ E-3/y). The initiating plant fire has a probability of $\leq$ E-1/y with an estimated probability of E-3/y that this fire is severe enough to spread and ignite any accumulation of material resident in the prefilter. Due to potential moisture (in a plant fire) and particulate loading from any fire, even should the final filters not ignite, the analysis assumes failure from wetting and overpressurization. The probability for this event given a fire in the prefilters is 1. This would not, however, cause a release of the magnitude of the total fire scenario. Release fractions from this event would likely be approximately 0.10 of the total particulate nuclide inventory.[54] The scenario assumes 100% of the material resident in the filters is released. The analysis also assumes that the final filters are contaminated to their maximally allowed loading. This combined simultaneous fire in both filters envelops any fire that may occur in the ventilation or POG systems.

Due to the inability to obtain a sample of the material on the prefilter, this estimate (as well as the input to the codes used to evaluate the accident) is not considered to be accurate beyond one significant digit.

It is assumed that even less serious fires could cause plugging and blowouts in the final filter banks. These releases are, however, bounded by the fire described here.

Including the 104 final HEPA filters in the fire scenario, the filters are presumed to be contaminated to their maximum limit of 20 mrem/h at the surface of the filter housing. The ratio of nuclides used in the analysis was derived from actual sample collection data. The data was evaluated and curie contents for each filter were determined based upon the 20 mrem/h allowed limit per filter. This ensured that the amount of material used in the calculation was consistent with the amount allowed by the technical specifications. The 20 mrem/h allowed limit was created to reduce personnel exposures during filter changeout operations and to be a conservative reading that would encompass a variety of process streams and limit the dose equivalent effects at the site boundary from an airborne release of radioactive material built up on a filter in the event of a release due to a filter fire.

Curie loading for the 104 final filters reading 20 millirem/h is as follows with a total activity of approximately 0.73 Ci:[38]

Nuclide	Total Ci Filter Loading
Sr-90	2.61 E-2
Y-90	2.61 E-2
Ru-106	1.12 E-1
Rh-106	1.12 E-1
Sb-125	1.84 E-1
Cs-134	3.44 E-3
Cs-137	6.77 E-2
Ba-137m	6.77 E-2
U-234	1.28 E-1
Pu-239	1.11 E-2
Am-241	8.52 E-4

Meteorological parameters were calculated for the maximum consequence at each location using differing meteorological classes for each calculation. The following down wind distances are listed with the corresponding TEDE:[38]

Downwind Distance (m)	TEDE (rem)
100 (ICPP)	2.26
2414 (TRA)	1.12 x E-1
4024 (CFA)	7.00 x E-2
14,000 (site boundary)	3.40 x E-2

Total Effective Dose Equivalent from Simultaneous Ventilation Prefilter and Final Filter Fire[38, 53]

Distance (m)	TEDE (rem)
100 (ICPP)	3.1
2414 (TRA)	4.1 E-1
4024 (CFA)	9.7 E-2
14,000 (site boundary)	4.3 E-2

These doses compare with maximally allowed doses for normal operation (as given in DOE Order 5400.5 and DOE/EH-0256T) in the following: occupational dose = 5000 mrem (5 rem) per DOE/EH-0256T and maximum allowed public dose (during normal operations) = 10 mrem via the airborne pathway. This accident then would closely approach the (DOE Order 5400.5, primary standard) public dose limit for normal operations.

The dose to workers and colocated persons would be in excess of the normal limits allowed by DOE/EH-0256T. Additionally, it may require an exception to the public dose limit (100 mrem/y) to continue operation of the ICPP. The public dose would, in all probability, never approach the value reported in the analysis, which assumes most of the material is transported to the boundary. It is reasonably assumed that the majority of the contamination in the prefilter is calcine. Even if this material were transported out the stack, a significant fraction would likely be removed from the plume long before it reached the public domain.

The LCOs and LCSs for operation are set at instrument sensitivity levels that ensure that doses at the nearest site boundary are detected before a total annual effective dose equivalent of 1.5 mrem is reached over a 24-hour period (maximum time between sample filter changes). A cumulative total is maintained for consecutive 12-month periods.

9.3.2 Ventilation Prefilter (CPP-756) Dust Fire

A fire could occur in the ventilation prefilter. The filter media are not combustible but some of the entrained dust may be. There are no ignition sources in the cell reducing the possibility for any entrained dust to ignite. As described above, ignition sources could be introduced into the vault as a result of an upstream fire in a cell or ventilation duct. The scenario for a prefilter fire is explained earlier. As long as the final filters were not breached, the release of radioactivity from this event would be mostly contained in the final filters. This fire is bounded by the fire involving both the prefilter and final filters.

9.3.3 Cell Ventilation Ducting Rupture

The ventilation duct from CPP-601 to CPP-756 has never been evaluated in a detailed structural study. It may not survive an earthquake and is also subject to vehicular accidents from trucks, cranes, etc. Missiles generated from high winds could also damage the ducting. If this occurs between CPP-601 and CPP-756, the damage would provide an unfiltered release route to the environment. The ducting has been examined for internal contamination and is contaminated to varying degrees up to 200 to 300 mrem/h per 100 cm^2 in removable dust. Should the duct catastrophically fail and result in a ground level release of the loose dust, personnel exposure to airborne radionuclides could occur within the confines of the ICPP exclusion area. The effects from collapse of the section between CPP-649 and the stack would be less severe. This section of the ducting is downstream from the APS ventilation filters and blowers and, as such, is not as contaminated. This accident is given a value of "2" in terms of consequence and risk. The consequence value is influenced more by the extent of personnel injuries than other factors. The consequence could be lower than postulated. It is highly unlikely that the consequence would be higher based upon the definitions provided in the table footnotes.

9.3.4 Collapse of the Main Stack, CPP-708

The description of the Main Stack has been provided in subsection 2.2. The Main Stack is seismically designed to withstand a 0.12-g horizontal motion earthquake. The stack will also withstand a 95-mph wind loading.

Collapse of the stack would, conceivably, place all personnel or structures within a 250-ft radius from the stack base at risk. Credit has been taken for some of these facilities being able to withstand this accident in previous SAR reports due to the density and thickness of the walls. There is no documentation available to support this claim today.

The worst scenario involving stack failure would be a failure that resulted in the Main Stack falling into the Tank Farm and releasing the contents of a high-level liquid waste tank. Rupture of one of these tanks is evaluated in PSD Section 4.2.

Due to the possibility of fatal injuries, severe damage to other plant facilities, and the potential for release of radiological materials, the severity of the accident is given in table 6 as "3". The probability for this type of failure is extremely unlikely (assigned level of 1). These products yield a risk number of 3, which is considered marginally acceptable. This is a conservative number that is obtained by assuming the worst possible stack collapse. Consequences are measured in a very limited range. The risk (consequences x probability) could be somewhat higher or lower based upon injuries and deaths resulting from the accident. The risk factor is driven to the higher values based upon the extent of personnel involvement, which can vary considerably. If no one is injured from the accident, the risk could be "2" and possibly "1". A factor of 3 is considered marginal. Due to the proximity of the stack to other structures, a risk value of "3" cannot be dismissed.

The stack was cleaned of loose contamination in August of 1992. A post-cleaning radiation survey indicated that radiation fields still exist after the cleaning. This radiation results from material deposited in the stack prior to the installation of the stack liner. An accurate conclusion cannot be made concerning the levels of this material or how much could be released in a stack collapse. Hanford decommissioned a stack similar to the Main Stack where radiation readings inside the stack were on the order of 1 rad/h after cleaning.

The Hanford stack was explosively toppled so that it would collapse into a prepared trench. No airborne activity was detected resulting from this process. Of course, a well-designed and controlled stack collapse has only limited value in comparison to an unplanned accidental collapse.

DOE Order 6430.1A specifies that the failure of an item that is not a safety class item cannot cause the subsequent failure of other safety class items. Stack failure may cause the simultaneous failure of safety class equipment within a 250-ft radius of the stack.

9.3.5 Fires Occurring in Filter Media

Fires that originate in filter caissons are considered an extremely unlikely event. The filters are fire resistant and are housed in noncombustible caissons. Nonetheless, these fires have been evaluated as to their impacts within the site boundary and off-site. Fires were modeled according to calculated curie loadings based upon the radiation level at which the technical specifications required their changeout.[34] As a result of these calculations, filter changeout criteria have been changed for many of the filters that may possibly be involved in fires.

The ventilation filters, for example, were allowed to reach 450 mrem/h. ***This has been reduced to 20 mrem/h.***

The worst fire scenario with HEPA-filter fires involves the 104 filters in the ventilation APS system in CPP-649. If these filters were loaded to the maximum amount allowed (an amount of activity when measured would produce 20 mrem/h as measured at the surface of the caisson) and if they were involved in a fire wherein all the contamination was released from the stack, the resulting doses would be as follow:[38]

Location	Distance from Stack	TEDE
ICPP	100 m	2.26 rem
ICPP	200 m	1.19 rem
TRA	2414 m	112 mrem
CFA	4024 m	70 mrem
Site Boundary	14 km	34 mrem

These calculated doses from this accident scenario are within the dose guidelines for occupational exposure as given in DOE/EH-0256T. The dose at the site boundary is beyond the dose allowed from normal operational exposures as given in DOE Order 5400.5 for the airborne pathway only (10 mrem).

DOE Order 6430.1A, Section 1300-1.4.2, provides limits beyond which events are considered as accidents and monitoring equipment must be safety class. The section is titled "Accidental Releases" and the criteria says, "Facility design shall provide attenuation features for postulated accidents (up to and including the DBAs) that preclude off-site releases that would cause doses in excess of the DOE 5400 series limits for public exposure." The 34 mrem dose at the site boundary is, however, still less than that provided in DOE Order 5400.5 for deviations beyond the 10-mrem limit. It should also be noted that the calculated dose to the public includes the ingestion parameter in the calculation as well as the inhalation, ground deposition, and the dose received from immersion in the radioactive cloud. The consequences from the event could be mitigated by controlling the post-event ingestion parameter, if advisable.

9.3.6 NO_x Exposure

An exposure to NO_x could occur at significant levels to overcome personnel exposed within the area and cause death or a disabling injury.

10. CONDUCT OF OPERATIONS

10.1 ORGANIZATIONAL STRUCTURE

Conduct of operations at the ICPP is governed by DOE Order 5480.19. Operations at DOE facilities are managed with a consistent and auditable set of requirements, standards, and responsibilities. The operations of the facilities include an acceptable level of safety management, procedures in place to control the conduct of operations, line organization review of programs, and assessment of effectiveness of directives.

The airborne waste management systems are an integral part of all ICPP facilities. Management controls employed by LMITCO for all facilities within the ICPP govern the conduct of operations of these systems. Management controls governing facility operations are described in detail in PSD Section 10.

10.1.1 Corporate Organization

The LMITCO president is responsible to the DOE-ID, which reports to the DOE Headquarters. Several independent organizations report to the LMITCO president. Additional organization and structure of LMITCO, as related to the safe operation of the ICPP complex, are described in PSD Section 10.

10.1.2 Operations Organization

The LMITCO president is responsible for ensuring that plant activities are conducted to protect the health and safety of plant personnel and the public and to comply with all applicable DOE-ID requirements. The LMITCO president is assisted by several vice presidents, branch vice president/general managers, and directors. The LMITCO Nuclear Operations Branch is responsible for operation of the airborne waste management systems. The LMITCO Nuclear Operations Branch and its functional responsibilities are detailed in Section 2 of PSD Section 10.

10.1.3 Personnel Qualification Requirements

Personnel qualification requirements for personnel operating equipment, calibrating instruments, maintaining equipment, and collecting samples from the airborne waste management systems are within the existing qualification requirements for LMITCO personnel. Written job descriptions establish education and experience requirements for each organizational position. Certain positions in the Nuclear Operations Branch (operator, senior operator, operating foreman, and operating supervisor); radiological control technicians (RCTs) in the Safety and Health Directorate; and technical shift engineers in the AEDL may be filled only by certified individuals. The certification process ensures that certain minimum qualifications are met.

10.2 TRAINING PROGRAMS

LMITCO programs for training process operators, operations supervisors, health physics technicians, and technical shift engineers are described in PSD 10, Section 2.1.4. Training programs have been utilized effectively to provide qualified personnel for fuel processing and waste management programs at the ICPP. LMITCO is committed to comprehensive evaluation and updating of training programs to provide for current and future training needs.

10.2.1 Personnel Staffing and Training

Operators and operations supervisors receive training as specified by the LMITCO INEL Institute. The Training Information Manual[55] provides for qualification and certification and complies with DOE Order 5480.5 and DOE Order 5480.20. LMITCO personnel normally conduct qualification training and certification. Assignment of trained personnel is accomplished by Nuclear Operations and the Safety and Health Directorate.

The INEL Institute is responsible for the RCT training program. Programs have been developed to familiarize RCTs with the physical facility, instrumentation to be used for process and facility monitoring, and personnel surveillance.

All personnel at the ICPP are required to have completed a radiation worker training class before they are assigned to unescorted work involving 1) entering a radiation field greater than 5.0 mrem/h, 2) entering a controlled surface contamination area, and 3) handling or working with radioactive or contaminated material. All personnel involved with the above work must attend two radiation worker classes (1 and 2) and must attend annual retraining sessions in order to maintain their status as trained radiation workers.

10.2.2 Annual Review Training

All certified personnel are required to participate in refresher training and to recertify every 2 years.

10.2.3 Administrative and Records

As an integral part of the INEL Institute Plant Training Program, up-to-date records are kept to track and document the training status of all personnel.

10.3 NORMAL OPERATIONS

The same management controls and practices used in conducting normal operation of other ICPP facilities are applied to the operation of the airborne waste management systems. These controls and practices are described in Sections 2 and 3 of PSD Section 10.

10.4 EMERGENCY PLANNING

The ICPP Emergency Action Plan is described in PSD Section 10, Subsection 2.4.4, and the LMITCO Emergency Action Manual.[56] The

Emergency Action Manual addresses DOE requirements for various events as follow:

Alert. An event in progress or having occurred that involves an actual or potential substantial reduction of the level of safety of the facility.

Site Emergency. An event in progress or having occurred that involves actual or likely major failures of facility functions needed for the protection of on-site personnel, the public health and safety, and the environment.

General Emergency. An event in progress or having occurred that involves actual or imminent substantial reduction of facility systems.

Facility design features provide for ease of personnel evacuation. Personnel exits are provided in accordance with the NFPA 101 Life Safety Code.[57] In those areas where a credible accidental breach of a primary confinement system (vessel, pipe, wall) could potentially expose personnel to radioactive material, a distance of approximately 23 m (75 ft) is the maximum travel distance to place personnel beyond or through the next confinement barrier. The assured airflow maintained by the ventilation system is in the opposite direction of the exit travel.

An evacuation alarm system, a criticality alarm system, and a public address (PA) system are provided for local area evacuation, and are incorporated into the existing overall ICPP evacuation system. A PA system is provided as part of the emergency warning system and is connected to the overall plant PA system. A fire alarm system is provided.

10.5 CONDUCT OF OPERATIONS FOR AIRBORNE WASTE MANAGEMENT AT THE ICPP

10.5.1 Plant Procedures and Performance Criteria

The operation and correct functioning of the airborne waste management systems are contained in LMITCO operating procedures. These detailed descriptions of operating requirements are maintained by the individual departments for the correct conduct of their work scope. These procedures are reviewed and checked for completeness to ensure that any safety-related requirements as specified in technical specifications and standards have been met.

Correct operation of the airborne waste management systems requires the interface of several organizations within LMITCO. Calibration data bases are maintained to ensure that safety-related instruments are regularly calibrated, preventive maintenance (PM) schedules are established to ensure that vital equipment receives periodic maintenance, and other internal programs are in place to ensure analytical dependability, for sample analyses, etc. These programs are routinely audited by the Nuclear Operations Quality Assurance Department to ensure that schedules are maintained, work is correctly completed, and analyses are accurate.

10.5.2 Decommissioning Requirements

Briefly, the requirements applicable to the ICPP are that all operational plans consider the needs for eventual D&D to a degree of detail consistent with the estimated remaining useful life of the facility. Facilities determined not to be necessary any longer are maintained under controls to protect employees and the public from potential hazards. D&D plans will be developed consistent with the following objectives: 1) converting the facilities to other missions; 2) maintaining the degree of surveillance required if D&D is not completed; 3) implementing the ways in which preventive, long-term maintenance can be reduced or eliminated; and 4) ensuring the possible interaction of the facilities with continuing DOE projects at the INEL.

10.5.3 Plans for Decommissioning

As facilities within the ICPP become obsolete, decommissioning plans are developed based on the proposed disposition or reuse of the facility.

Such plans require approval and budget allocations by DOE. Plans for decommissioning facilities within the ICPP include as many of the following features as practicable:

1) The organizational unit last assigned operating responsibility for the facility will retain responsibility for decontamination and other approved elements of the specific decommissioning plan unless the facility is transferred to an organization such as engineering or plant projects for decommissioning.

2) All removed and packaged radioactive materials will be taken from the facility. Allowed residual levels will conform to approved limits.

3) All parts of the facility will be decontaminated to radiation levels that will permit personnel access for demolition work.

4) Contamination will be removed or fixed in place in accordance with applicable ICPP health physics procedures and standards.

Any reuse or further decommissioning of the facility must be proposed as a new construction project through the DOE budgeting system. If the facility is to be reused, the necessary demolition and preparation for the new use is included in the project proposal for the new installation.

10.5.4 Design Features for Decommissioning

Much of the ICPP was designed for direct maintenance and generally contains many features important to decommissioning activities.

10.5.5 ICPP Decommissioning

Decommissioning of individual facilities within the ICPP and of the entire ICPP will be determined by the direction and budget provided by DOE when and if the time comes. The mission of the ICPP, however, is projected to continue for many years to come. Upon a determination that the mission of the plant is completed, specific plans and cost estimates will be developed and budgets requested. Trade-off studies will determine the most effective application of funds consistent with 1) protection of people and the environment and 2) the cost of surveillance versus demolition and removal.

Shutdown of the ICPP will require, as a minimum, decontamination of the entire facility to the extent practical, and solidification of all high-level liquid waste. New facilities may be required to package the solidified high-level waste for transport to another location.

11. SAFETY-RELATED REQUIREMENTS

This section of the PSD for the Management of Radioactive Airborne Effluent lists the features and controls that are required for the safe operation of the ICPP. These features and controls comprise the operational safety requirements (OSRs) inclusive of ESFs and administrative controls.

As stated in DOE Order 6430.1A, ESFs are those SSCs that are provided to prevent or mitigate the potential consequences of postulated DBAs. An ESF system is a safety class system. All safety class systems are not, however, ESFs.

SSCs are classified for safety purposes according to the consequences of the failure of each SSC. The consequences could be direct (the SSC failure causes a release of hazardous material) or indirect (the SSC failure, subsequently along the release path, results in an unspecified release of any magnitude that is not monitored or sampled). In the former situation, an SSC could be considered to be safety class if the failure of that SSC could cause an effective dose greater than a determined level or if the SSC could fall upon, impact, or otherwise affect a neighboring item that is safety class. In the latter situation, a monitor could be considered to be safety class if that monitor might be required to monitor a release in excess of normal operating releases. A release sufficiently above normal releases would be considered an accident. According to DOE Order 6430.1A, releases in excess of the DOE Order 5400.5 are considered accidents. Safety class SSCs are subject to more stringent design considerations, redundancy, resistance to natural hazards, etc.

Within this realm of safety class SSCs is the group of ESFs. These are safety class items that are designed and installed only for the purpose of preventing or mitigating accident consequences above the lower threshold of safety class SSCs. This classification of SSCs is intended to discriminate those systems that must function and provide their services after the accident has occurred from those that are provided for normal operational reasons only. In other words, an ESF may function most of the time as an SSC that provides service in an ALARA capacity. Its intended function is, however, to prevent or mitigate a release beyond ALARA considerations. An SSC installed only for ALARA purposes is not an ESF. SSCs in this category are considered "general service."

In addition to the more stringent design considerations required by the fact that all ESFs are safety class SSCs, the capability of the ESF to perform its intended service must be periodically field-verified. This verification ensures that the ESF continues to validate the safety analysis assumption that it will mitigate or prevent the consequences of the DBA.

The analysis of an SSC according to its intended purpose in the reduction of unfavorable consequences arising from industrial activities results in the proper allocation of human and financial resources relative to the consequences of the SSCs failure. It also allows a distinction between items that are important for other reasons (efficiency, productivity, etc.) from SSCs that are important primarily because of their significance to public, occupational, and environmental safety. Resource allocation is directed to those SSCs according to the importance of that SSC in maintaining the safety envelope for the operation in which it functions. The following definitions apply to the determination of the various classes of SSCs:

Safety Significant. SSCs with on-site effects that could have a significant impact on a facility or co-located personnel. Significant impact would be radiological doses greater than or equal to 5000 millirem.

Safety Class. SSCs that have a significant impact on meeting the criteria for public safety. This significant impact would include those items specifically listed in DOE Order 6430.1, e.g., environmental monitors required to monitor accidental releases, etc. An unusual or accidental release is one that exceeds the guidelines for normal operation. Monitoring is required during accidental releases. Safety class airborne environmental monitors are those that monitor processes or activities where the maximum accidental or unusual release may exceed 10 mrem TEDE in the off-site location. Safety class equipment, other than the list of six SSCs in DOE 6430.1A, Section 1.300-3.2, is designated as safety class if the off-site TEDEs are greater than or equal to 500 mrem through any individual exposure pathway or a summation of all pathways. All equipment classified as safety class equipment is designed and operated according to more strict standards than general use SSCs. In the case of monitoring equipment at the ICPP, safety class equipment is determined through safety analysis. The graded approach described in DOE Order 5480.23 and DOE Standard 3009 is used in the safety analysis. Refer to the discussion in subsection 1.2.1 describing the application of this process to safety analysis.

Engineered Safety Feature. An ESF is a safety class feature designed to prevent or mitigate an off-site CEDE greater than or equal to 5000 mrem or to mitigate consequences of more serious accidents after the accident has occurred. This CEDE may be determined through one pathway or a summation of all exposure pathways, depending on the nature of the release. Other safety class items installed to mitigate lesser releases are not considered ESFs, even though they may function in that capacity during larger accident conditions. In other words, HEPA filtration, which is installed for normal operations, will normally provide mitigation of the release after an accident has occurred. These filters are not, however, ESFs unless they are installed specifically for that purpose and an accident analysis indicates that the consequences from the accident exceed the CEDE of 5000 mrem. ESFs are structures, systems, or components installed only for the reasons discussed above and require periodic field-verification that they can still perform that safety function.

The design basis for an SSC is a determining factor in the assignment of safety classification. While an ESF could provide mitigation below the limiting value of 5000 mrem CEDE, thereby preventing the dose, it is not necessary for the SSC to do so to be considered an ESF. In other words, an SSC installed to mitigate a release is required to provide mitigation above a CEDE of 5000 mrem, but it is not required to provide mitigation to levels below a CEDE of 5000 mrem.

A 5000 mrem CEDE, when averaged over the lifetime (50 years) of the exposed person, is equal to the primary standard of 100 mrem TEDE. ESFs are, using this criterion, designed and installed in consideration of those accidents that exceed the primary standard (DOE Order 5400.5) when the CEDE is averaged over a person's lifetime. In some instances a single release may not cause a dose in excess of 5000 mrem CEDE. If a probabilistic analysis indicates that this release might recur more than once during a 50-year period, and the sum of these repeated releases could cause a CEDE greater than or equal to 5000 mrem, then equipment installed to provide mitigation during these releases could be considered ESFs.

11.1 OPERATIONAL SAFETY REQUIREMENTS

OSRs are those safety analysis requirements met and carried out by ESFs and administrative controls.

11.1.1 Engineered Safety Features

There are no ESFs currently identified within the ventilation or off-gas systems at the ICPP. There are SSCs within ventilation and off-gas systems that provide prevention or mitigation of radiological releases but the consequences of their failure are not within a safety class, or ESF realm of probability, consequence, and risk. Special SSCs such as those required to monitor accident conditions (DOE Order 6430.1, Section 1300-3.2) may, depending upon the consequence of the accidental release, be classified as safety class SSCs.

Even though other systems are not designed as ESFs and are not considered to be safety class systems, they have been designed and are maintained to provide many of the same functions as a safety class system. These general-use SSCs function to mitigate the consequences from normal operations and may prevent or mitigate consequences occurring during unusual periods of operation. The design and purpose of these systems is to provide for the control and mitigation of airborne radioactive materials, direct them into areas where accidental personnel injury cannot occur, and eliminate as much of them as possible prior to release into uncontrolled areas. A primary consideration in the design, installation, and use of these SSCs is to achieve the goals of the ALARA program.

It is the goal of ICPP operations that these general-use items are designed, installed, and operated consistent with safety class standards but without incurring the additional cost in designing, purchasing, installing, and maintaining actual safety class SSCs. The ability of a general-use SSC to provide its ALARA function is not significantly compromised even when individual components of the system are failed or removed from service. The design and installation of these SSCs provide, where possible, elements of reliability and redundancy so that single failures will not significantly compromise the entire system. Administrative controls are used to increase this confidence. The HEPA-filtration systems at the ICPP are examples of this type of SSC. HEPA-filtration systems are installed to provide ALARA controls for normal operational effluent. They also are likely to mitigate the consequences of most accident conditions. Even though they serve in this dual capacity, they are not installed primarily for the purpose of accident mitigation. HEPA filters are not ESFs, even though internal procedures and practices maintain the filters in a manner similar to that of an ESF.

Only pretested HEPA filters are used in HEPA applications and, when installed, an in-place test based upon national standards verifies that they are not damaged. For an accident situation in which the filters are not destroyed, filter efficiencies are assumed to be somewhat lower than the pretest would indicate. This is assumed across the entire filter stage. Individual filters may vary in efficiencies from installation to installation. The decontamination factor for each stage of HEPA filtration is acceptable if each filter passes the in-place test prescribed in the national standard. Variation between filters is allowed. These variations may be in several degrees of efficiency, providing a filter bank or stage meets the total decontamination factor specified in the in-place testing procedure.

Consequence analyses indicate that the SSCs are not safety class. Failure of these SSCs will not result in safety class level (off-site) consequences. These SSCs are considered to be safety significant. They are important in the maintenance of ALARA program and industrial safety goals but they are not required to maintain the safety envelope of the entire facility. Procedural controls ensure the availability of these systems during most accident situations. The SSCs may not survive the worst natural phenomena event.

Monitoring requirements for ARPs are considered to be safety class if the unusual release can exceed 10 mrem TEDE at the off-site location. These monitors are provided with sampling redundancy and, where possible, are provided with other safety class back-up systems.

Redundant, nonsafety class sampling systems are sometimes installed where releases may exceed 0.1 mrem TEDE. The redundancy is included if the operation cannot be readily or economically terminated should a single train fail. These monitors are still considered to be general use.

Monitoring is required during all periods of normal activity in which a release may occur with an TEDE exceeding 0.1 mrem/y. If the activity may be easily terminated (and resumed) should the monitor fail, and, if the TEDE cannot exceed 10 mrem/y, a single-train monitor is acceptable. If the cost of termination is significant in terms of lost operating time or if sudden termination may cause other undesirable consequences, redundancy, partial redundancy, and other means for increasing instrument reliability are considered. General service samplers do not have to be totally redundant (i.e., they may rely upon a single sample point that divides into two separate sample collection devices). UPS or emergency power is not required.

Continuous sampling is required for all processes that could cause a release in excess of 0.1 mrem TEDE during the periods of their operation.[58] Lacking redundancy, radioactive processes that could cause an off-site TEDE in excess of 0.1 mrem must be terminated when the sampler is out of service for any reason. Shutdown of radioactive processes must be initiated within 4 hours of the discovery of the failure of both trains. The four-hour time period allowed prior to the initiation of the termination of all radioactive processes that could cause an off-site TEDE in excess of 0.1 mrem is based on realistic repair history data on the main stack monitors. Dose consequence analysis performed on postulated accident releases are well below current dose consequence evaluation guidelines.[59] Bringing processes to shutdown conditions reduces the probability that an accidental release will occur during a time coincident with monitor outage.

If continuous monitoring (real time) is also provided, a timely quantifying of these releases can be provided. Real-time effluent monitoring is used when other methods of accident detection are not available or where such information can be used to quickly quantify the release for response purposes. A sampler consisting of various filter media and designed to provide data after a criticality, for example, does not require a safety class real-time monitor to detect the release. CASs that are safety class will detect the accident. A real-time detection of a short burst of activity from a stack does not enhance the safety of the system or the facility response to an event.

11.1.2 Administrative Controls

Administrative controls establish the safety envelope for the operation of the ICPP. They define the conditions, safe boundaries, and bases for operation. Administrative controls protect the health and safety of the public reduce the potential risk to workers from the release of radioactive or other hazardous materials. They are written into the technical specification and standards and are included in PSD Section 15. The format for these administrative controls is as follows:

1) Surveillance Requirement: A surveillance requirement (SR) is a test, calibration, or inspection requirement to ensure the operability and quality of safety-related SSCs and the support systems necessary for safe operation of a facility.

2) Limiting Control Setting: An LCS is a setting on a process variable for a safety system that controls the facility function. It prevents exceeding any associated SL. In the case of airborne effluent, the LCS prevents the regulatory guidelines from being exceeded. If the automatic alarms or protective devices do not function as required during applicable operating modes, the contractor shall take action as defined in the LCS to maintain the variables within the requirements and to promptly repair the automatic devices or to shut down the affected part of the process, and if required, to shut down the facility.

3) Limiting Condition for Operation: An LCO is the lowest functional capability or performance level of safety-related SSCs and their support systems required for normal, safe operation of the facility. LCSs are set below this level to ensure that this lowest performance level is not approached or exceeded during normal operations. An LCO is the point at which maximum effort must be taken to prevent or mitigate an unfolding accident scenario.

4) Safety Limit: An SL is a limit on a process variable that is necessary for a specific facility function. SLs are requirements that guard against the uncontrolled release of radioactive and other hazardous material. Some administrative controls do not include SLs because they are not required to guard against an uncontrolled release. Imposition of an SL will not enhance the facility response to the event. An example of this is the limits for airborne effluent.

Regulatory limits are set far below levels that could cause immediate health effects to acutely exposed individuals. Regulatory limits are established to control chronic exposures. When a regulatory limit is approached, the operator will take all necessary and possible action to prevent or mitigate the release. An SL imposed above this regulatory limit cannot prescribe additional action on the part of the operator. In these situations LCOs, with defined actions, serve the function of the SL.

If an SL is exceeded, the nuclear facility shall be immediately placed in the most stable, safe condition attainable, including total shutdown, except where such action might reduce the margin of safety. For airborne effluent, regulatory requirements (and LCOs) mandate shutdown to a stable condition long before any release threatens a member of the public. These regulatory limits eliminate the need for an additional SL. In the event of a release approaching a regulatory limit for normal operations, plant processes would be terminated. LCOs require termination of activities and compliance to these regulatory limits.

The following specific controls and requirements are included in a technical specification/standard (TS/S). They provide system requirements for the off-gas and ventilation flows with TS/S-level concerns. Safety class monitors have LCSs, LCOs, and SRs included in various TS/S (currently under evaluation for inclusion in the TSR format of DOE Order 5480.22). Changes in the ICPP mission will change the safety classification of some SSCs. The FAST stack monitor, for example, is included in a TS/S in the PSD. With the change in the ICPP mission, this monitor is currently under evaluation and will be changed to a general-use status. LCSs, LCOs, and SRs written for the monitor will, in future documents, not be included in TSRs but in ICPP operating procedures. The administrative controls included in the TS/S follow below: (Detailed requirements are given in the individual TS/S document.)

1) Ventilation filters are changed when the radiation reading reaches or exceeds 20 mrem/h as measured at the filter housing. The CPP-666 filter changeout criteria are as described in PSD 5.6. Process filters are changed at levels appropriate to their service and to the accident consequences resulting from filter failure.

2) Airborne radiological effluent is measured and analyzed to ensure that release rates and total releases are maintained to acceptable levels on an operational basis.

3) HEPA filters used for maintenance of primary or secondary confinement are tested in-place when installed to ensure that leakage and penetration are acceptable and to verify that the filters are properly installed and have not been damaged during shipping and installation. Annual testing of the HEPA filtration is performed, and acceptance criteria are based upon national standards [American Society of Mechanical Engineers Standards ASME-N510[60] and others, as appropriate]. Industrial safety engineers conduct the tests based upon ventilation flow rates and aerosol characteristics.

4) Instrumentation required to verify and to provide a real-time notification of particulate releases is Group I. Instruments are calibrated and source-checked on a regular basis.

5) Instrument alarms are set to provide realtime notification of any off-normal releases. These settings are sufficiently low to ensure that notification is given well before a steady rate of increase can exceed release restrictions and to implement mitigating actions for all releases above normal.

6) All radioactive release points, where required per DOE 6430.1 and 5400.5, are sampled and monitored on a real-time basis. Cumulative, running totals are maintained as a summation of all radioactive releases.

7) A nominally isokinetic sample, proportionate to stack flow, is constantly withdrawn from stacks requiring safety class monitors during periods when a radiological release might occur. Plant processes are shutdown when the particulate sampling and on-line particulate monitors cease to operate. Ventilation flows and POG and VOG vacuums are normally maintained during these periods. While radioactive processing is terminated, other

instrumentation (CAMs, RAMs, etc.) will detect accidents that may release material to the ventilation system. Releases that might occur during simultaneous periods of process termination and instrument unavailability are of low probability and will not exceed normal operational limits. The CAMs, RAMs, etc., are not Group I when in service as back-up. They may, however, be Group I instruments for other service situations. Processing involves those activities that, during normal operations, exhaust radioactive airborne effluent into the POG system at the ICPP.

8) Specifications and standards define operability requirements for important (safety class) components of the ventilation, off-gas, and monitoring systems. Specifications and standards require the termination of plant processes be initiated within 4 hours when these requirements are not satisfied.

9) Release limits and instrument settings for the Main Stack and the NWCF stack are established by TS/S requirements. Instrument settings are verified by calculations based upon instrument sensitivity, efficiency, and the Cs-137 source standard.

10) In the event of abnormal releases, processes are shut down in an orderly fashion until the source of the release is determined and the rate of release is reduced to acceptable levels. An orderly fashion is one that does not compromise the safety of the ICPP or its environs due to the shutdown. If completed, an orderly shutdown will lead to a safe shutdown configuration. Some equipment important for safety or whose function removes radioactive particulate from the off-gas (e.g., the scrubbers at the NWCF, any ion exchange system, etc.), may be left in service if it is determined that the equipment is not the source of the release.

11.2 OTHER SAFETY CONSIDERATIONS

In addition to the OSRs, there are other items that are of a safety concern but cannot result in occurrences with TS/S levels of consequence and are not associated with safety class equipment. These other concerns are usually listed in lower level documents and internal operating procedures. Previously, some of these items were considered as TS/S but due to changes in the operation or design of the systems or because there is new information available, these items no longer have TS/S-level significance. These considerations are discussed below:

1) Inactive processes that still have available airborne routes to the environment are maintained with HEPA filtration. Because the processes are inactive, the filters are tested when installed but no further maintenance, surveillance, or annual testing is required until so stipulated by the D&D SAR or after being screened and evaluated in accordance with USQ procedure using the current authorization basis.

2) Windspeed and direction data that might be useful during a plant emergency is obtained from ICPP instrumentation, NOAA links, or other facilities at the INEL. Due to the redundancy of data availability and the addition of computer linkups and real-time computer analysis, independent instrumentation at the ICPP is not required.

3) D&D projects are evaluated for the need to take special precautions regarding operation of off-gas systems and filtration media during D&D efforts. D&D is a complete, stand-alone process that places the facility in a final state of permanent retirement. Before the D&D process is begun, interim decontamination may be conducted. Extant requirements when the facility was operational normally describe decontamination procedures used during shutdown. These procedures are sufficient for most interim decontamination iterations. USQ screening is completed on current safety documents to verify the adequacy of the procedures used prior to the complete D&D effort

and to ensure that any configuration changes are within the approved authorization basis. When required, SARs are prepared for the post-interim D&D process. Some D&D projects can proceed to completion using the current authorization basis and the USQ procedure.

4) Changing the configuration of an off-gas or ventilation system requires a USQ screening to determine whether the change is within the currently approved authorization basis. The evaluation of any proposed configuration change to ventilation and off-gas systems is completed in accordance with USQ screening procedures. Routine maintenance and processing variables allow configuration changes when described in the authorization basis or in reviewed and approved operating procedures. Changes to ventilation and POG SSCs other than those described in the authorization basis are screened to determine whether any change constitutes a USQ.

5) Pressure differentials across HEPA filters are established and monitored for increasing Δp. Filters are changed when the Δp reaches or exceeds 10 in. w.g. (1 in. w.g. equals 2.458×10^{-3} atmosphere pressure.) Pressure differential instruments for POG-APS final filters are routed to the plant DCS so transient pressure spikes that can indicate a failed filter are detected immediately. Failure of a filter, by itself, will not result in an unacceptable release. Failed filters are replaced upon detection or alternate filtration paths are used. Pressure differential instruments for upstream process filters detect gradual increases in Δp indicating change-out is required at 10 in. w.g. When transients cause filter failures upstream of the APS final filters, the filter failure can be detected by accelerated deposition on the final filters or through increasing deposition of radioactive particulate in the stack sample.

6) Effluent monitoring for nonsafety class monitors where the potential release could exceed 0.1 mrem TEDE at the nearest site boundary is required during periods of normal operation. Operations are terminated when the instrumentation is out of service.

12. QUALITY ASSURANCE

LMITCO policy requires that all plant operations work activities be performed in a manner that meets or exceeds established quality requirements. In accordance with the requirements of ANSI/ASME NQA-1-1989[61] and DOE Order 5700.6C,[62] a quality assurance (QA) program has been developed for the ICPP. This program provides a system of control for items and activities that affect quality at the ICPP. Implementation of the QA program is controlled through implementation of the ICPP quality assurance program manual.[63]

The ICPP quality assurance program manual, by the issuance of quality methods and procedures, addresses environmental protection quality assurance, and the following NQA-1 requirements:

- Organization
- Quality assurance program
- Design control
- Procurement document control
- Instructions, procedures, and drawings
- Document control
- Control of purchased items and services
- Identification and control of items
- Control of processes
- Inspection
- Test control

- Control of measuring and test equipment
- Handling, storage, and shipping
- Inspection, test, and operating status
- Control of nonconforming items
- Corrective action
- Quality assurance records
- Audits.

12.1 ORGANIZATION

The quality assurance program is implemented through the use of procedures. The organization is discussed in QMP 1-1, "Organization," in the quality assurance program manual. The LMITCO president has ultimate responsibility for managing the ICPP. The president delegates the responsibility and authority for developing the QA program and coordinating QA functions to the director of the Quality Assurance and Oversight Directorate. The president also delegates the responsibility and authority for implementing the QA program to members of the principal staff who direct activities that affect quality.

12.2 QUALITY ASSURANCE PROGRAM PLAN

The responsible organizations implement plans for training when project specifications require training, qualification, and certification prior to operation of the systems. Indoctrination for the purpose of familiarizing personnel with quality-related procedures and policies is conducted on the job.

Work control procedures are used that require tools, gauges, instruments, and other measuring devices to be in accordance with specification requirements. Procedures used during operation, and operations themselves are subject to QA reviews and audits. Procedures are used to ensure that special processes are performed by qualified and certified personnel using qualified procedures. Nuclear Operations Quality Assurance performs surveillance and inspection for control of special processes.

13. DOE ORDER 5480.23 COMPLIANCE

This section provides supplemental information to ensure the reader that adequate programs and controls are in place at the ICPP to meet the requirements specified in DOE Order 5480.23 and DOE Standard DOE-STD-3009-94. This SAR is only one section of the PSD. It is written to comply with Regulatory Guide 3.26 format and content requirements.[64] This section addresses the PSD and ICPP OSRs, management, organization, institutional safety provisions, emergency preparedness, maintenance, hazardous material protection, human factors, procedures, and training.

13.1 PLANT SAFETY DOCUMENT

The overall risk from all operations at the ICPP is covered by the existing PSD, which is the collection of all final safety analysis reports (FSARs). The PSD is composed of 19 volumes of FSARs for all ICPP operations requiring safety analysis. There are four volumes of associated TS/S, which are derived from the PSD.

The upgrade to the ICPP SAR will incorporate the applicable material in accordance with DOE Order 5480.23 requirements. The SAR upgrade is currently scheduled and will be completed in accordance with the ICPP DOE Order 5480.22 and DOE Order 5480.23 implementation plan.[65]

13.2 OPERATIONAL SAFETY REQUIREMENTS

Currently at the ICPP, the safety envelope is defined by SARs and the OSRs. The OSRs are composed of physical and administrative controls. The physical controls are the safety class SSCs or any ESFs as defined by the DOE Order 6430.1A requirements. Administrative controls are 1) the technical specifications for off-site consequences to the public and 2) the technical standards, technical safety requirements (TRQs), and procedural controls are for on-site consequences to workers, the plant, and equipment. TS/S are approved by the DOE. The TRQs are approved by LMITCO. LMITCO submitted the implementation plan[65] to DOE-ID for conversion of the ICPP TS/S to TSRs in accordance with DOE Order 5480.22. LMITCO is in the process of accomplishing the implementation plan.

The following definitions and criteria are used at the ICPP for establishing ESFs, TS/S, and TRQs:

ESFs in Accordance with DOE Order 6430.1A. Systems or design characteristics that are provided to prevent or mitigate the potential consequences of postulated design basis accidents. An ESF system is a safety class system. These features are provided for mitigation of more severe accidents and are specifically provided for these types of accidents. ESFs do not include SSCs specifically provided for other purposes even though they may provide mitigation for these more serious accidents.

LMITCO Technical Specification Criteria.

1) Release of radioactivity (in the air or water) off-site of the INEL site that could result in an annual dose commitment of more than 500 mrem (whole body, gonads, and bone marrow) or 1.5 rem (other organs) to a member of the general population.

2) Release of nonradioactive material (in air or water) off-site of the INEL site (at receptor level for air release) that would exceed the standard for any pollutant or toxicant as specified in State of Idaho or federal regulations.

LMITCO Technical Standard Criteria.

Worker Protection

1) Nuclear Criticality.

2) Radiation dose to individuals (single exposure).

a) 5 rem (whole body, head and trunk, gonads, lens of eye, red bone marrow, and active blood-forming organs).

b) 15 rem (unlimited areas of the skin, except hands and forearms, and other organs, tissues, and organ systems, except bone).

c) 30 rem (bone and forearm).

d) 75 rem (hands and feet).

3) Internal uptake of radioactive material resulting in an annual dose commitment to any individual exceeding criteria 2 above.

Operating Concerns.

1) Loss or damage of government property amounting to $1 million or more (including cleaning, decontamination, renovation, replacement, and rehabilitation of structures, equipment, and property).

2) Plant downtime greater than 2 years.

LMITCO TRQs. TRQs are controlled documents that provide formal supplementary instructions to ensure that the intent of TS/S is met. They protect the plant and personnel from safety hazards, expense, or downtime of less importance than those covered by TS/S.

13.3 MANAGEMENT, ORGANIZATION, AND INSTITUTIONAL SAFETY PROVISIONS

PSD Section 10 provides a detailed description of ICPP policy directives. The policy directives, together with the ICPP standard operating procedures (SOPs), implement the safety policies of LMITCO and the DOE. PSD Section 10 also describes the conduct of operations; general safety control of operations, processes, and plant configuration; documents that control the ICPP safety envelope; QA; decommissioning; and OSRs.

LMITCO's graded approach to conduct of operations is in accordance with DOE Order 5480.19, "Conduct of Operations Requirements for DOE Facilities."[66] The conduct of operations relative to ICPP systems is described in procedures.

The following controls are in the category of general safety control of operations:

1) Operations Controls, which envelop operations planning; operational procedures review; audit, surveillance and appraisal practices; and personnel selection, staffing, and training procedures.

2) Process Controls, which envelop Category I and II devices, Group I instrumentation, ESFs, chemical additions, process computer systems and their monitoring functions, the process control and warning system (PCWS), and analytical chemistry for process quality control.

3) Configuration Controls, which envelop all physical modifications of ICPP facilities.

4) Health and Safety Controls, which envelop nuclear criticality safety, radiological safety, industrial safety, emergency planning, transport of hazardous and radioactive materials, and environmental protection.

The following descriptions are of documents controlling the safety envelope and their use:

1) General policy documents for safety analysis at the ICPP.

2) Environmental assessments, environmental impact statements, SARs, the PSD, safety assessment documents, and special work permits that result from the safety analysis process for new systems and modifications of old systems.

3) Operations control documents, including OSRs (ESFs and TS/S), SOPs, and documentation of unusual and unplanned events.

In the discussion of OSRs relative to management controls, emphasis is placed on management responsibilities for controlling processes, configuration of the physical plant, and the safety documentation to ensure the integrity of the plant safety envelope. The management controls that are incorporated into the OSRs as administrative controls, are contained in the 10E series of the TS/S. The controls complement the TS/S approved for the other individual sections of the PSD and the generic controls (15C series of the TS/S) located in PSD Section 15.

13.4 EMERGENCY PREPAREDNESS

The Emergency Action Manual provides a plan of action to ensure the safety of all people (employees, other contractor personnel, visitors, and the general public) who are within the ICPP during an emergency. Potential emergency events are categorized and classified, and protective action guidelines are established for both radiological and nonradiological exposures. The emergency response and support organizations are described, and the organizational structure is presented with a clear succession of authority for emergency situations. Utilization of an emergency control center is detailed in the Emergency Action Manual. The responsibilities and operations of an on-scene command center are also defined.

13.5 MAINTENANCE PROGRAM

ICPP policy is to develop, implement, and document a program to ensure that maintenance activities are conducted in a cost-effective manner in order to preserve or restore the availability, operability, and reliability of SSCs important to safe and reliable operation of the ICPP.

These activities include corrective, preventive, and predictive maintenance. This policy is addressed in Policy Directive 9-04[67] and is implemented by procedures. Among these, the procedures most descriptive of the program and its conduct are SOP P-0.60, "Preventive Maintenance Administration,"[68] and WSOP WE-20, "Preventive Maintenance Activities."[69] SOP P-0.60 provides preventive maintenance equipment custodians and others instructions for carrying out their duties and responsibilities under the preventive maintenance program. WSOP WE-20 provides procedures for administering and documenting preventive maintenance performed on all equipment that requires preventive maintenance.

The Maintenance Implementation Plan[70] describes the status of the overall maintenance program for the ICPP compared to the 18 objectives and guidelines in DOE Order 4330.4B, Chapter II.[71] The implementation schedules provided in the plan allow for the incremental implementation of improvements to the maintenance programs over a 4-year period. Some of the program improvements are contingent upon receiving additional resources above current budget target levels. During the various assessments of the ICPP maintenance programs, no programs or practices were identified that jeopardized the health or safety of plant employees or the general public.

13.6 HAZARDOUS MATERIAL PROTECTION

The hazardous material protection program is described in the Industrial Safety Manual. In addition to defining general policies and administration, the following specific aspects, which are relative to the hazardous materials program, are discussed in detail:

Industrial hygiene - general policy

Respiratory protection

Chemical handling safety

Mercury

Asbestos

Organic solvents

Handling cadmium and cadmium compounds

Handling and application of pesticides

Carcinogens

Paint and special coating application

Notification of employee overexposure

HEPA filter systems

Hazard communication

Operation and testing of laboratory hoods.

13.7 HUMAN FACTORS

Those facilities constructed prior to the early 1980s were not subject to the many human factors considerations that exist today. Facilities designed and built since then have undergone human factors review both by the architect-engineering firms involved and the design review system. Human factors reviews are guided by DOE Order 6430.1A, NUREG-0700,[72] UCRL-15673,[73] and UCRL-15688.[74]

13.8 PROCEDURES AND TRAINING

PSD Section 10, in section 2.1, describes the development, review, approval, and use of control procedures and the training of personnel. Some of the items discussed are the following:

1) The types of operational controls.

2) Operational procedures review and approval.

3) Audits, surveillance, and appraisals.

4) Procedural compliance.

5) Procedures for accountable nuclear material.

6) Personnel selection, staffing, and training of process operators, supervisory personnel, technical shift engineers, maintenance craftspersons, and operational health physics technicians.

Complete details of the training program are presented in a document titled, "Training Implementation Matrix for US DOE Order 5480.20: Personnel Selection, Qualification, Training, and Staffing Requirements at DOE Reactor and Non-Reactor Nuclear Facilities."

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